BBC wildlife

APRIL
2025
Issue 05 Vol 43

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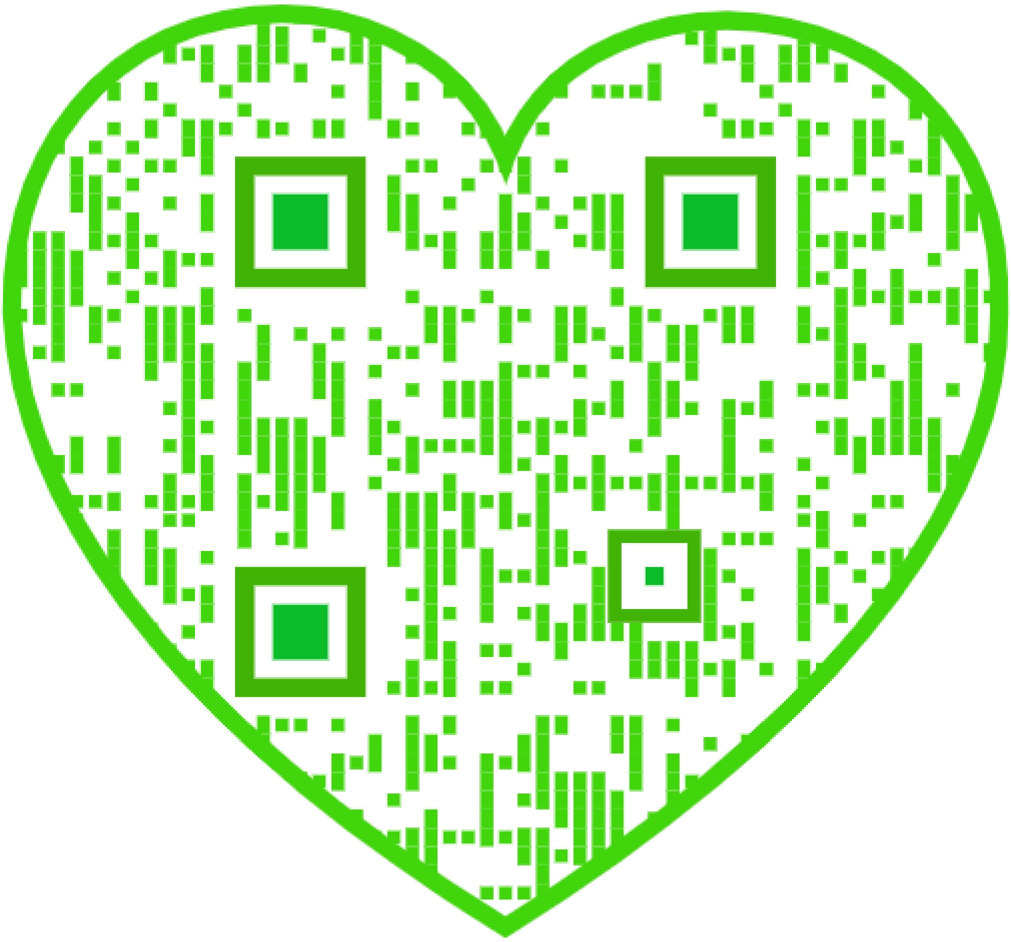
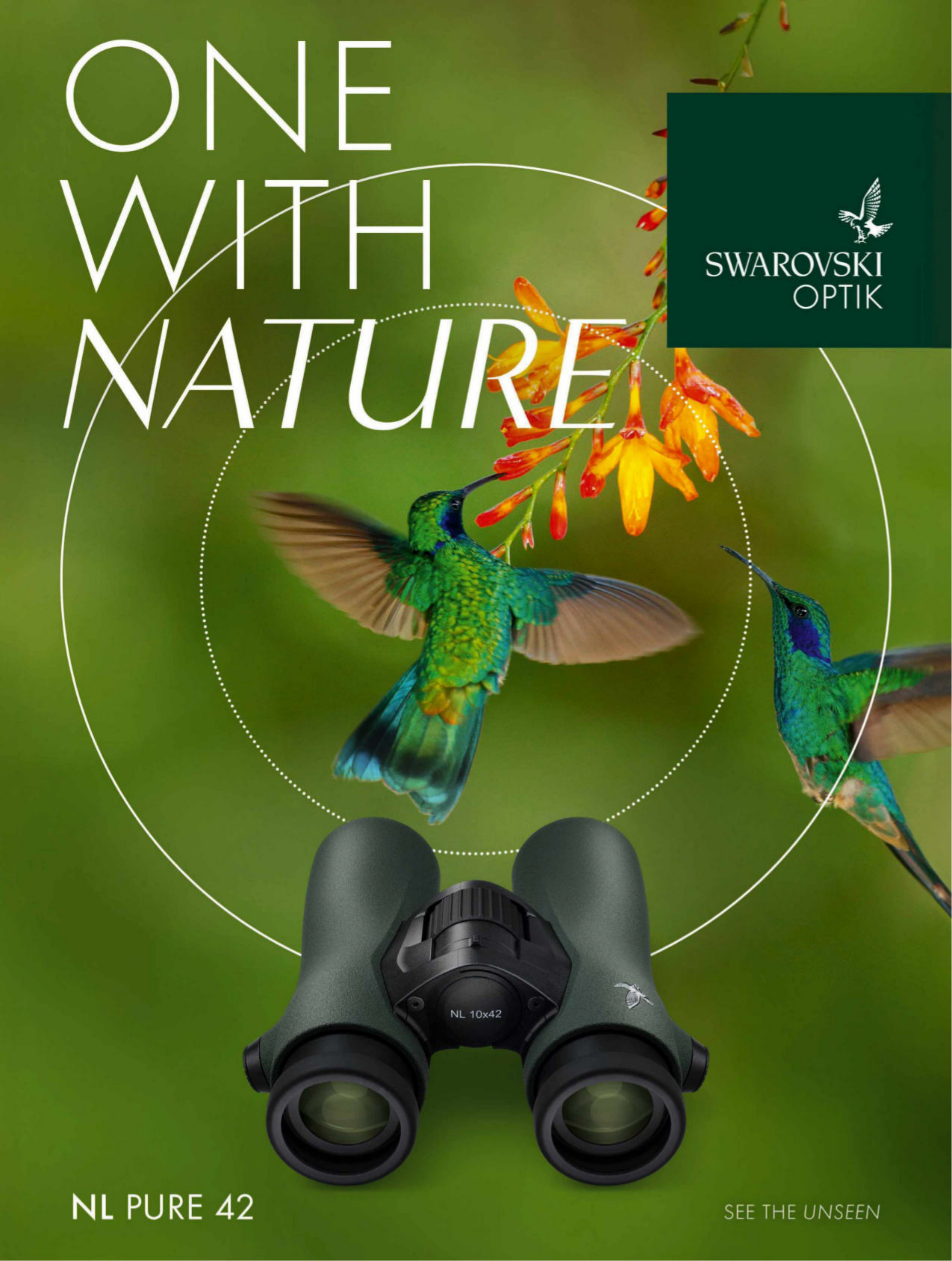
PARADISE FOUND

In search of Papua New Guinea's most extraordinary birds

Plus

Killer hornet invasion
Caiman protectors of Peru
The great zoo debate

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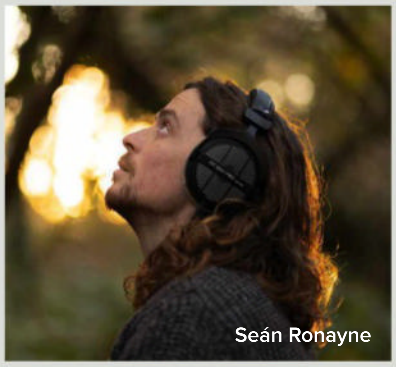
ON THE BBC THIS MONTH

Where the Polar Bear Waits

BBC iPLAYER As scientists in Churchill, Canada, race to understand how to protect polar bears that are threatened by climate change, the town works to keep increasingly hungry bears away from its population.
Catch up on iPlayer


Seán Ronayne

Birdsong

BBC iPLAYER Follow Irish ornithologist Seán Ronayne as he sets out to record the sound of every bird species in Ireland – that's nearly 200 birds. Seán travels to some of the country's most beautiful locations to capture its most elusive species.
Catch up on iPlayer

This Natural Life

BBC SOUNDS Martha Kearney meets wildlife cameraman Hamza Yassin in a bird hide at the London Wetland Centre. As birds fly past the hide window, Hamza speaks of hope in the face of all the difficulties facing our natural world.
Catch up on BBC Sounds

CAIMAN: LOUIS GUILLOT; POLAR BEAR: JOHNER IMAGES/ALAMY; SEÁN RONAYNE: CHRIS MADDALONI

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- wildlifemagazine@ourmedia.co.uk
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A white caiman near the Tambopata River in the Amazon

You never forget your first crocodilian

PAUL McGUINNESS, EDITOR

I have a personal reason for enjoying Louis Guillot's feature about caimans in Peru's Tambopata reserve (*p64*), a place I visited about 15 years ago. I still recall the thrill of my first night there. My senses had never been so overloaded – the intense heat and humidity, the trees and plants, macaws overhead and pudus wandering around the lodge, butterflies of every colour, and what sounds!

As dusk fell, our guide, Percy, helped us aboard his boat and we pushed off. It wasn't long before Percy shone his torch at the water's edge and pointed out two clear orange dots: the reflective eyes of my first wild crocodilian. We watched for a few seconds that felt like hours and then it was gone.

Every wildlife experience is special – from the caimans of the Amazon to the woodpecker I saw from my garden last week – but some are just that bit more special than others.

Paul

BBC wildlife

EDITOR
Paul McGuinness

MANAGING EDITOR **Sarah McPherson**
ACTING PRODUCTION EDITOR **Oliver Hurley**
GROUP DIGITAL LEAD **Debbie Graham**
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CREATIVE LEAD **Stacey Black**
CREATIVE DESIGNER **Annie Sanderson**
GROUP VISUAL EDITOR **James Cutmore**
CONTENT CREATOR **Sophie Ellis**

CONTRIBUTORS
Nick Baker, Stuart Blackman, Gillian Burke, JV Chamary, Dustin Chen, Lucy Cooke, Mike Dilger, Guy Edwardes, Holly Exley, James Fair, Louis Guillot, Kirsten Henton, Ben Hoare, Melissa Hobson, Jules Howard, Cate Langmuir, Derek Nielsen, Joe Pontin, Jenny Price, Jo Price, Peter David Scott, Richard Smyth, Wanda Sowry, Leoma Williams

ADDRESS **Our Media, Eagle House, Bristol, BS1 4ST, UK**
EDITORIAL ENQUIRIES **wildlifemagazine@ourmedia.co.uk**
SUBSCRIPTION ENQUIRIES **bbcwildlife@ourmediashop.com**
FACEBOOK **@wildlifemagazine**
X (TWITTER) **@WildlifeMag**
INSTAGRAM **@bbcwildlifemagazine**
WEB **discoverwildlife.com**
YOUTUBE **bit.ly/bbcwildlifeyoutube**

ADVERTISING
PARTNERSHIP SOLUTIONS MANAGER **Dan Baker** *0117 300 8280*
dan.baker@ourmedia.co.uk
CLIENT SOLUTIONS MANAGER **David D'Souza** *0117 476 7335*
david.dsouza@ourmedia.co.uk
CLIENT PARTNER **Amy Thacker** *0117 476 7310*
amy.thacker@ourmedia.co.uk
BRAND SALES EXECUTIVE **Anthony Jago** *0117 300 8543*
anthony.jago@ourmedia.co.uk
BRAND SALES EXECUTIVE **Marc Hay** *0117 300 8758*
marc.hay@ourmedia.co.uk
INSERTS **Laurence Robertson** *00353 876 902208*
laurence.robertson@ourmedia.co.uk

LICENSING AND SYNDICATION
HEAD OF LEGAL **Emma Brunt** *0117 300 8979*
emma.brunt@ourmedia.co.uk
DIRECTOR OF LICENSING AND SYNDICATION **Tim Hudson**

MARKETING
SENIOR PERFORMANCE MANAGER **Kellie Lane**
PERFORMANCE MANAGER **Chris Rackley**
SENIOR LOYALTY & ENGAGEMENT MANAGER **Aimee Rhymer**
SENIOR MARKETING MANAGER – DIGITAL EDITIONS **Kevin Slaughter**

PRODUCTION
PRODUCTION DIRECTOR **Sarah Powell**
DEPUTY PRODUCTION MANAGER **Emily Mounter**
SENIOR AD CO-ORDINATOR **Charles Thurlow**
AD DESIGNER **Parvin Sepehr**

BBC STUDIOS, UK PUBLISHING
SVP GLOBAL LICENSING **Stephen Davies**
GLOBAL DIRECTOR, MAGAZINES **Mandy Thwaites**
COMPLIANCE MANAGER **Cameron McEwan**
uk.publishing@bbc.com

OUR MEDIA LTD
CEO **Andy Marshall**
MANAGING DIRECTOR **Andrew Davies**
BRAND LEAD **Daniel Bennett**
HEAD OF BRAND MARKETING **Rosa Sherwood**

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Apr.

BBC Wildlife No. 05 Vol. 43

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PARADISE FOUND

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THE COVER

This month's cover star is a beautiful king bird of paradise, photographed by Dustin Chen in the Aru Islands, off New Guinea. He used a Sony A1, focal length 600mm, f4 and 1/320sec. "I used 'zone focus' mode because my canopy hide was so close to the lek that even my Sony 600mm could barely catch the whole body in the frame," says Dustin. *See p54*

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Join pelicans feasting in Greece

PELICAN: GUY EDWARDES; BROWN BEAR: BRISTOL ZOO PROJECT; PUFFERFISH: DAVID FLEETHAM/NATUREPL.COM; HEDGEHOG: АЛЕКСЕЙ КОРНЕЕВ/ALAMY

Every month, only in *BBC Wildlife*

NICK BAKER
"It looks like a chipolata sausage to which some joker has attached the front end of a mole cricket" *p32*

GILLIAN BURKE
"I've always had an unease about how we talk about wildlife and nature in the wildlife film industry" *p25*

MARK CARWARDINE
Unfortunately, we're unable to feature a column from Mark this month but he'll be back next issue

LUCY COOKE
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MIKE DILGER
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How studying caimans in the Amazon can help the species' conservation

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Find out about the role of the modern zoo

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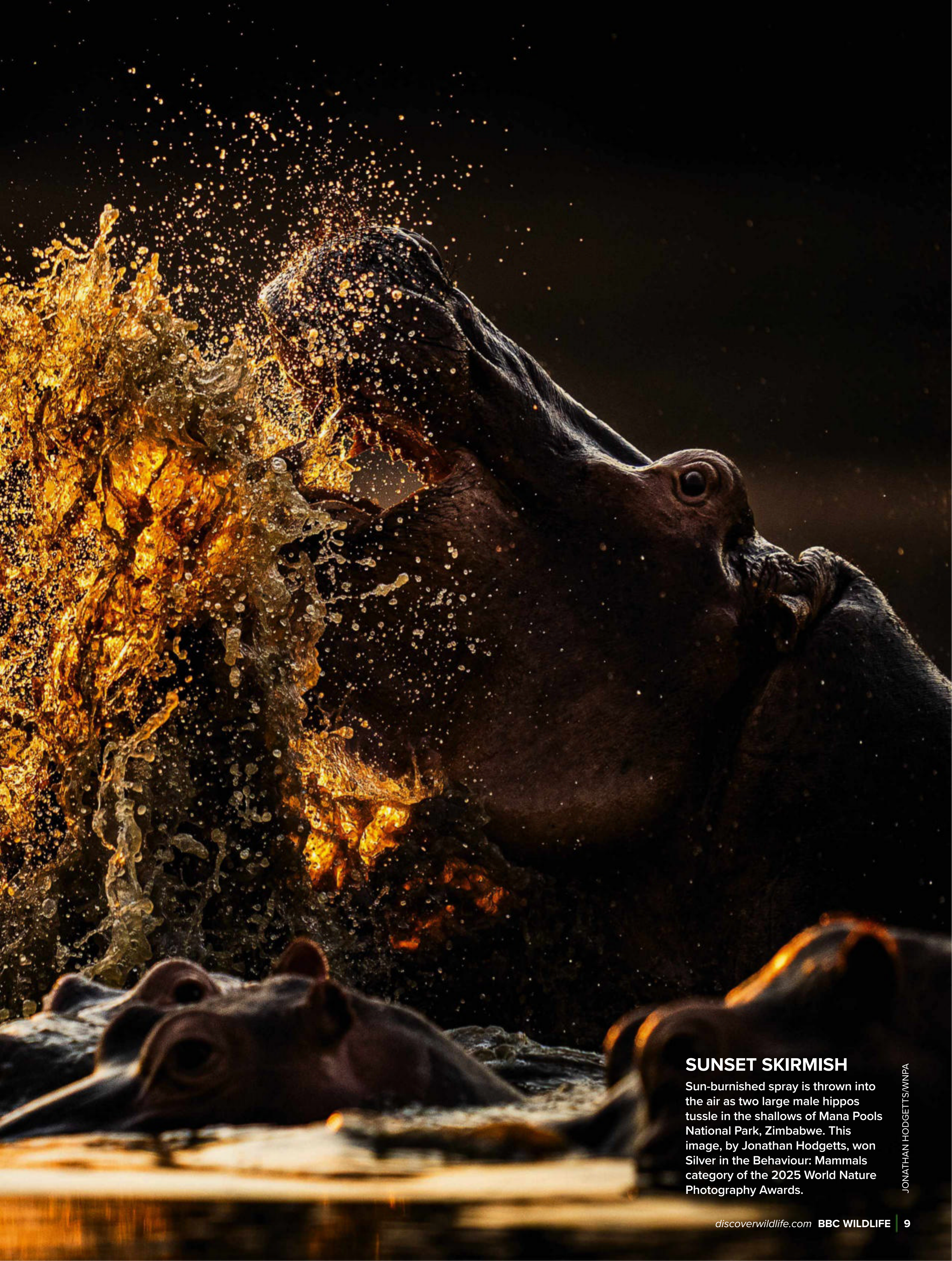
wild TIMES

The latest news, photography and seasonal wildlife highlights



SUNSET SKIRMISH

Sun-burnished spray is thrown into the air as two large male hippos tussle in the shallows of Mana Pools National Park, Zimbabwe. This image, by Jonathan Hodgetts, won Silver in the Behaviour: Mammals category of the 2025 World Nature Photography Awards.

JONATHAN HODGETTS/WNPA

Reef crabs nurse wounded coral

Tiny crustaceans could help protect stressed reefs during heatwaves

A SMALL REEF CRAB IMPROVES OUTCOMES for stressed corals during heatwaves, according to a new study in *Proceedings of the Royal Society B: Biological Sciences*.

Some crab species have mutualistic relationships with coral, and scientists now think these can help coral in times of stress. They carried out an experiment during a heatwave, using samples of the branching coral *Acropora aspera* and hoof-clawed reef crabs (*Cyclodius ungulatus*), placing them in tanks fed with water from Australia's Great Barrier Reef.

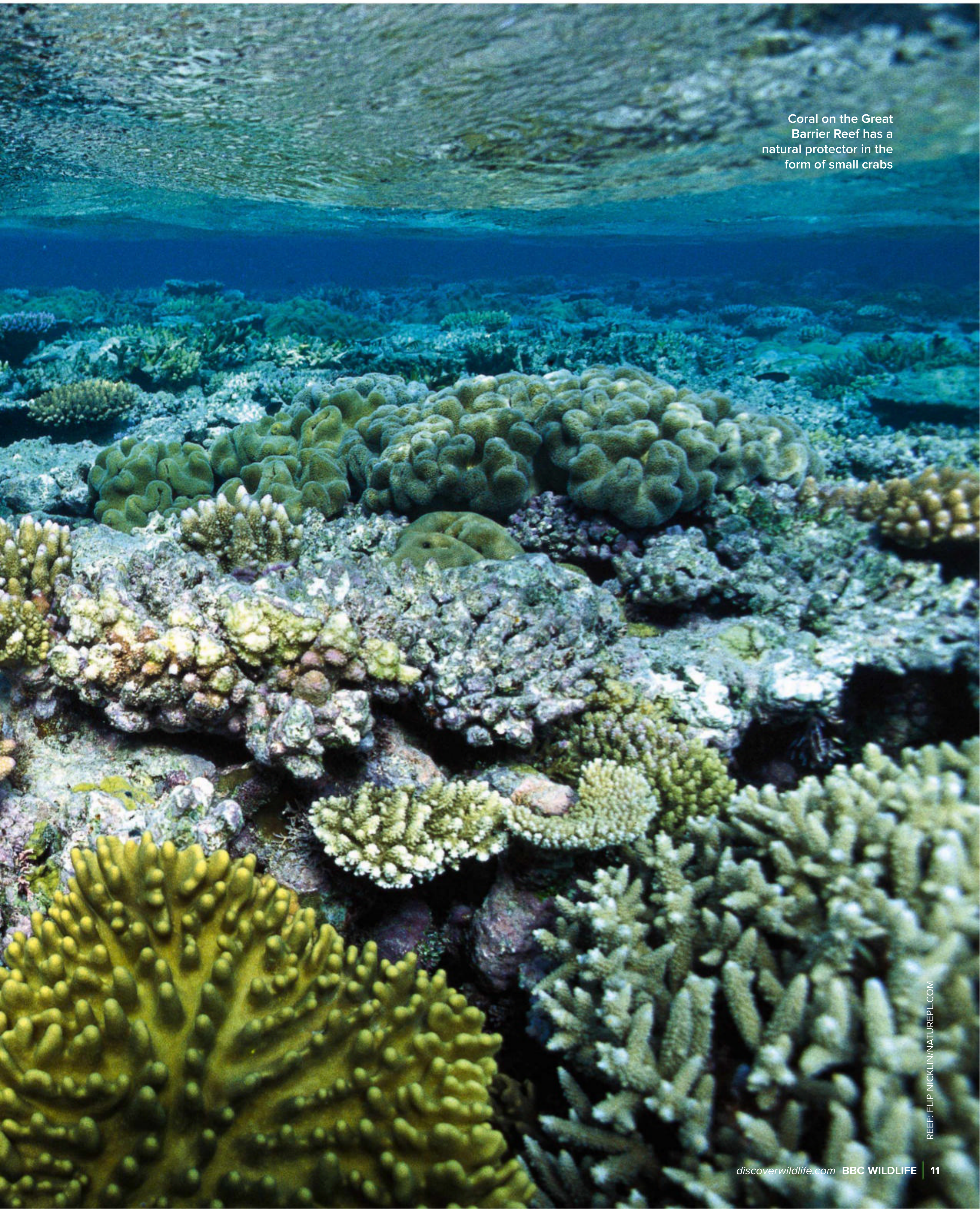
The tanks replicated various scenarios. Some of the corals had wounds, some were exposed to harmful algae, and some were housed with crabs. Some were exposed to multiple combinations.

Over a month, the scientists found that, as expected, the higher water temperatures triggered coral tissue loss as a stress response, particularly for those in contact with the algae. However, where a crab was present, the coral was more than 60 per cent less likely to suffer significant tissue loss. Coral exposed to algae also lost less tissue.

Surprisingly, being wounded appeared to be a good thing. Corals had the best outcome when there was no algae, they had a wound and a crab was present. "We expected to find an interaction between wounding and algae – ie a wound would make it easier for algal pathogens to invade coral tissues and cause tissue loss – in the same way a wound might predispose a person to infection if they swam in dirty water," says Julianna Renzi, lead author of the study. "Instead, wounding reduced tissue loss if a crab was around."

The crabs appeared to feed on the dead tissue around the edge of the injury – just as maggots do – which may have aided recovery.

The findings could help scientists better understand coral survival in the face of stressors. "We see a lot of variability in which colonies across a reef die during stressful events," says Renzi. "I think species interactions are a missing component in our understanding." **Melissa Hobson**



Coral on the Great Barrier Reef has a natural protector in the form of small crabs

REEF: FLIP NICKLIN/NATUREPL.COM

African grasslands, such as here in Amboseli, Kenya, support both wildlife and people

Grasslands for peace

Restoring this vital habitat reduces human-wildlife conflict and eases social tension

AFRICA’S GRASSLANDS ARE PROBABLY WHAT most people imagine when they think of the continent – vast plains teeming with wildlife. But beyond the famous tourist reserves, grasslands are also vital areas for people. In Kenya, for example, they support 60 per cent of livestock as well as 70 per cent of wildlife outside of protected areas.

In some areas, overgrazing and climate change-related droughts are leading to degradation of these ecosystems, leading to both conflict with species such as elephants, giraffes and lions as well as conflict between the people who use them.

Researchers from the nature NGO Conservation International tested whether grassland restoration reduced these conflicts for the benefit of both people and wildlife. They surveyed more than 1,500 households in the Chyulu Hills of southern Kenya, where 11,000 hectares of grassland have been restored through better livestock management, shrub management and reseeding of degraded areas.

“As restoration has increased, there has been a decrease in the number of social and human-wildlife conflicts,” says Camila Donatti, lead author of study, published in *Frontiers in Environmental Science*.

Donatti believes this is happening because the increased availability of grassland resources helps to minimise competition for them. “Elephants, for instance, are less likely to rely on crops if they have enough to eat in the grasslands,” she says.

By increasing the area available, conflict with carnivores such as lions and spotted hyenas is also reduced because encounters between them and livestock are less likely. “And if there is more space and resources for pastoralists, they are less likely to compete with other pastoralists,” adds Donatti.

With the increasing frequency of droughts across many parts of Africa, managing grasslands will become ever more vital in the years to come. Droughts cause encroachment of woody vegetation (because they have more access to water as a result of deeper roots), to the detriment of both people and wildlife. **James Fair**

Liz Bonnin reports from the Klamath River

Our Changing Planet back on BBC One

THIS MONTH SEES THE RETURN of *Our Changing Planet*, the ambitious seven-year television project that was first broadcast in 2022. The series visits threatened ecosystems across the globe, following the scientists and conservationists fighting to protect them. This year’s hour-long episode, *Restoring Our Rivers*, presented by Liz Bonnin and Ade Adepitan, highlights two extraordinary river restoration projects.

Liz reports from the Klamath River in northern California, where the largest dam-removal project in US history is underway. The Klamath was one of the largest salmon runs on the west coast until hydroelectric dams were built in the 1900s. The salmon were blocked from reaching their spawning grounds and populations plummeted. After decades of campaigning, the dams are finally being removed, restoring the river’s health.

Meanwhile, in Paris, Ade Adepitan investigates the huge clean-up of the River Seine. For decades, the capital’s ageing sewer system had leaked raw sewage into these waters, killing off aquatic wildlife. Ade finds out which species are making a comeback – and even goes for a dip – before visiting the European Space Agency to discover a potential solution to urban river pollution: toilets that separate and collect urine to be used as agricultural fertiliser. **Sophie Ellis**

GRASSLANDS: PAWEL GAUL/GETTY; LIZ BONNIN: JOHN HARRINGTON/BBC STUDIOS

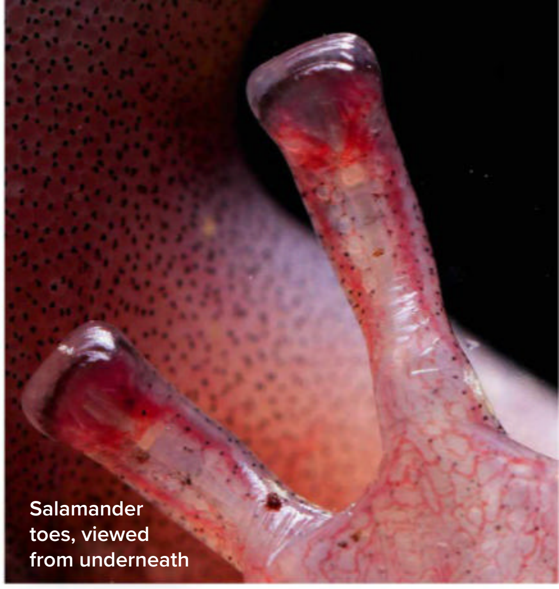
wild TIMES

A mega-iceberg the size of Cornwall, A23a calved from Antarctica's Filchner Ice Shelf in 1986. It remained grounded on the seabed until 2020, when it started to drift north, but became stuck in an ocean vortex. Now, it's on the move again – and heading for South Georgia

King penguin

ICEBERG ESCAPADE

In December, the world's largest iceberg, known as A23a, broke free from Antarctica after being trapped for months in an ocean vortex. It is now on a collision course with South Georgia. Some scientists think it could obstruct feeding routes for penguins and seals, increasing juvenile mortality. Others think it may bring rich nutrients to the surface, encouraging plankton blooms and, in turn, prey abundance.



Salamander toes, viewed from underneath

Salamanders have blood-powered toes

Physiology in the feet is the secret to agility

Wandering salamanders are known for their agility when traversing the high redwood canopies in their native northwest California. However, how they leapt and landed so assuredly was something of a mystery – until now.

The tips of a salamander's square-shaped toes are covered with translucent skin that encases visible blood 'lakes', which were previously assumed to aid oxygenation. But new research by Washington State University, published in the *Journal of Morphology*, has found that salamanders actually fill, trap and drain these lakes to fine-tune their locomotion control.

The study revealed that, by regulating blood flow to the sides of their toe tips, the salamanders can adjust pressure asymmetrically, improving grip on irregular surfaces such as tree bark. In addition, by sending a rush of blood to their toes, they can aid detachment. The extra blood slightly inflates the toe tips, reducing the area in contact with a surface and thus minimising the energy required to let go. Such dexterity is crucial when navigating the uneven surfaces of the canopy, and for safe landings when parachuting between branches.

Understanding this mechanism may aid bio-inspired designs, such as prosthetics and even robotic appendages. "Gecko-inspired adhesives already allow surfaces to be reused without losing stickiness," says lead author Christian Brown. "Salamander toes could lead to similar breakthroughs in attachment technologies." **Kirsten Henton**

ICEBERG A23A: GALAXIID/ALAMY; KING PENGUIN: SAMANTHA CRIMMIN/ALAMY; SALAMANDER TOES: WILLIAM P GOLDENBERG

Rise of the killer hornets

Asia's yellow-legged hornet has a toehold in Britain but we're keeping it at bay – for now

> "She'll lay up to 2,000 eggs, feeding them once they hatch. That's when she starts to wreak havoc"

It's early April and yellow-legged, or Asian, hornet queens that managed to evade the nest-destroyers from the UK's National Bee Unit (NBU) last year are just waking up from their long winter hibernation.

Though it is native to the generally much warmer climate of south-east Asia, the yellow-legged hornet is extremely adaptable and has found continental Europe and the UK much to its liking since it arrived in France back in 2004.

A hornet queen spends April building up her reserves by feeding on sugar-rich foods, such as tree sap and nectar. She also constructs the year's first nest from rotting wood, which she mixes with her saliva to create a hollow, papier-mâché-esque ball. When that's ready, she'll lay up to 2,000 eggs, feeding them once they hatch.

And that's when she starts to wreak havoc. Because yellow-legged hornets feed voraciously on other insects, including domesticated honeybees, to satisfy their

The yellow-legged hornet has a striking orange face and thick, golden hairs on its head and thorax, giving it a fuzzy appearance

BBC iPLAYER
The Killer Hornets is available on iPlayer

Nests are built high in trees and can house thousands of hornets

> **"A honeybee colony provides the convenience of a supermarket"**

brood's requirement for protein. One nest of larvae can consume up to 11kg of insects, and it's long been feared – ever since the species was first officially recorded in Britain in 2016 – that the yellow-legged hornet could have a devastating impact not just on honeybees, but also on other pollinators, such as solitary bees, hoverflies and even bumblebees, should it become established.

Peter Kennedy, a research fellow at the University of Exeter who has been studying yellow-legged hornets since 2016, says domestic honeybees are a particular target. "They like to concentrate on aggregations of insects, and a honeybee colony provides the convenience of a supermarket as opposed to visiting lots of local stores," he says.

In the autumn, Kennedy has observed yellow-legged hornets predating bees at honeypot sites, such as flowering ivy. "They patrol these places and just pick off what they want," he says. Our native European hornet, in contrast, does feed on honeybees, but is not a specialist hive predator.

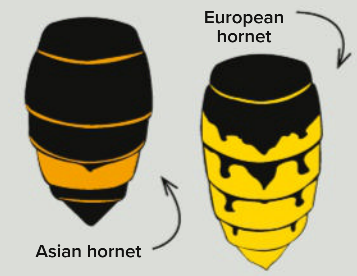
BUT WHILE WE KNOW THAT BEEKEEPERS in France have suffered losses averaging 30 per cent of their colonies across the country, the picture for native wild pollinators is less clear. "You'd have hoped that, with hornets being present in France all this time, we'd have a much better handle on the impact they're having on native species, but in most cases we didn't have the baseline data to say if numbers have really declined," says Kennedy.

Kennedy and his colleagues have carried out a study, due to be published this year, in which they analysed the DNA of hornet larvae to identify what the adults have been predating. They found evidence of bumblebees, even though they have also published a study that shows bumblebees – unlike other insects – are often able to escape hornet attacks.

Despite the lack of clarity, the UK authorities are taking the threat of the yellow-legged hornet seriously. Operatives from the NBU investigate any confirmed sightings and trace individual insects back to their nests, which are then destroyed. In 2024, 43 nests were eliminated; in 2023, 72. The fact that numbers declined last year is not seen as consequential – the overall trend, though not well set, is upwards.

The first yellow-legged hornet found in the UK arrived in a consignment of cauliflowers, but the British Beekeepers Association points out that there are various ways in which these insects can get here. They are not just hitchhiking in produce but also on ferries and in caravans, and are

HORNETS IN FOCUS



- The yellow-legged hornet is 25-30mm long – much bigger than a wasp.
- Its body is mostly black or dark brown, with a yellow segment on the tail, and it has yellow lower legs. The European hornet has more yellow on its tail and is slightly larger.
- The giant woodwasp, hornet hoverfly and dark giant horsefly can all be mistaken for the yellow-legged hornet.
- The yellow-legged hornet is no more aggressive to humans than the European hornet, and its sting is no more painful.
- For more information, visit nationalbeeunit.com or download the Asian Hornet Watch app.

HORNET: NATURE PRODUCTION/NATUREPL.COM; NEST: CHRISTOPHE GEYRES/ABACAPRESS/ALAMY; ILLUSTRATION: NNSS

Yellow-legged hornets are expert hunters, hovering outside beehives and seizing their prey in mid-air

HORNETS: JEAN-BERNARD NADEAU/LOOK AT SCIENCES/SCIENCE PHOTO LIBRARY

“The policy in Jersey is to go all out to find nests and then destroy them. We can’t eradicate the hornets, though”

even potentially carried by the wind, if it’s blowing in the right direction. According to Kennedy, this is suspected but not certain. “Seven nests found below the White Cliffs of Dover does suggest there was an event that favoured multiple landings,” he says.

Beekeepers on Jersey are on the frontlines of the battle, owing to the island’s location close to the French coast. They identified 262 nests in 2024 and 339 the year before and, according to volunteer John de Carteret, who helped to found the Jersey Asian Hornet Group in 2017, there’s no hope of eradicating the species.

“The policy in Jersey is to go all out to find nests and then destroy them,” he explains. “We can’t eradicate the hornets, though; we can only suppress their numbers. Eradication in our geographical location would be almost impossible.”

The question for British beekeepers and conservationists is whether that is also true of Britain. A paper published in 2024 by scientists at the UK Centre for Ecology & Hydrology (UKCEH) said the species had not yet become established here but would have done had it not been for the coordinated response of the authorities and volunteers.

Kennedy says it’s almost a question of semantics as to whether the species is established or not. “We are right on the cusp of where it might have established,” he adds.

Helen Roy, an ecologist at UKCEH, takes a different view. “As long as the response keeps going in the way it has been, we have every hope to stop it,” she says.

SUCCESSFULLY DISTINGUISHING yellow-legged hornets from European hornets – as well as from other lookalike insects such as the hornet hoverfly – is, of course, key (*see box*). Thanks to continued work by UKCEH and other organisations to promote awareness of the species, there is a “fantastic level of engagement” with the issue, according to Helen Roy.

“During the month of the Chelsea Flower Show last year, we had something like 20,000 sightings,” she says. Of course, the vast majority of those were not yellow-legged hornets, and this creates a massive workload for the organisation because it has to consider every potential record.

Kennedy and colleagues are addressing this by creating an AI system on a platform known as Vespa.ai. Using a bait station and camera, the system has learned to distinguish the yellow-legged hornet from our native species and from other, similar-looking insects.

“We are confident that it is 99 per cent correct,” Kennedy says. They don’t quite understand how the system knows what it is looking at, but the “shape of the hornet and certain colour patterns are important; the yellow legs are not”.

Nonetheless, this new tech has its limitations. The feeding station and camera attachment have been made using 3D printing, which would be too expensive for a mass rollout. And so far, the system has only been used in a situation where it can connect to wi-fi rather than a mobile 4G signal.

We have more than 2,000 species in this country that are classed as non-native but the vast majority are harmless. Only 10 per cent are termed invasive, which means they are likely to have an impact, whether environmental, economic or to human health. Such species can be very damaging and there are always more on the horizon – other hornets, such as the oriental hornet, could reach Britain eventually.

According to Helen Roy, the next significant invasive species could be a non-native ant – Argentine ants in London have been shown to survive the winter and could wreak havoc if they get into the broader environment. Globalised trade and travel mean we can never let our guard down when it comes to wildlife.

ABOUT THE AUTHOR

James Fair is a wildlife journalist with a specialism in conservation and controversial issues. Read more at jamesfairwildlife.co.uk.

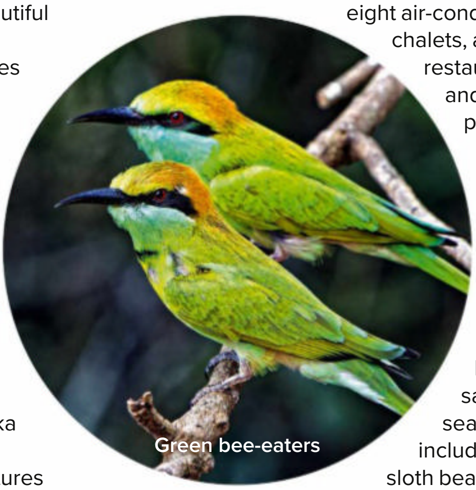
ADVERTISEMENT FEATURE

SAFARI WITH A DIFFERENCE

The endemic Sri Lankan leopard

Spot elephants, leopards, crocodiles and hundreds of bird species in Sri Lanka, a safari destination like no other

Think of safari and Africa probably springs to mind. But Sri Lanka, an island nation located in the Indian Ocean, also offers incredible opportunities for wildlife sightings and birdwatching. This beautiful country is home to breathtaking landscapes and a huge variety of animals, including the largest population of Asian elephants on Earth. Plus, palm-lined beaches and year-round warm weather make it a dream holiday destination.



Green bee-eaters

BRILLIANT BIRDLIFE

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wild *APRIL*

7 nature encounters for the month ahead

WITH NATURALIST AND AUTHOR BEN HOARE

1

Hedgehogs are most active, and noisy, at night and males can travel up to 3km in their search for a mate

Hectic hogs

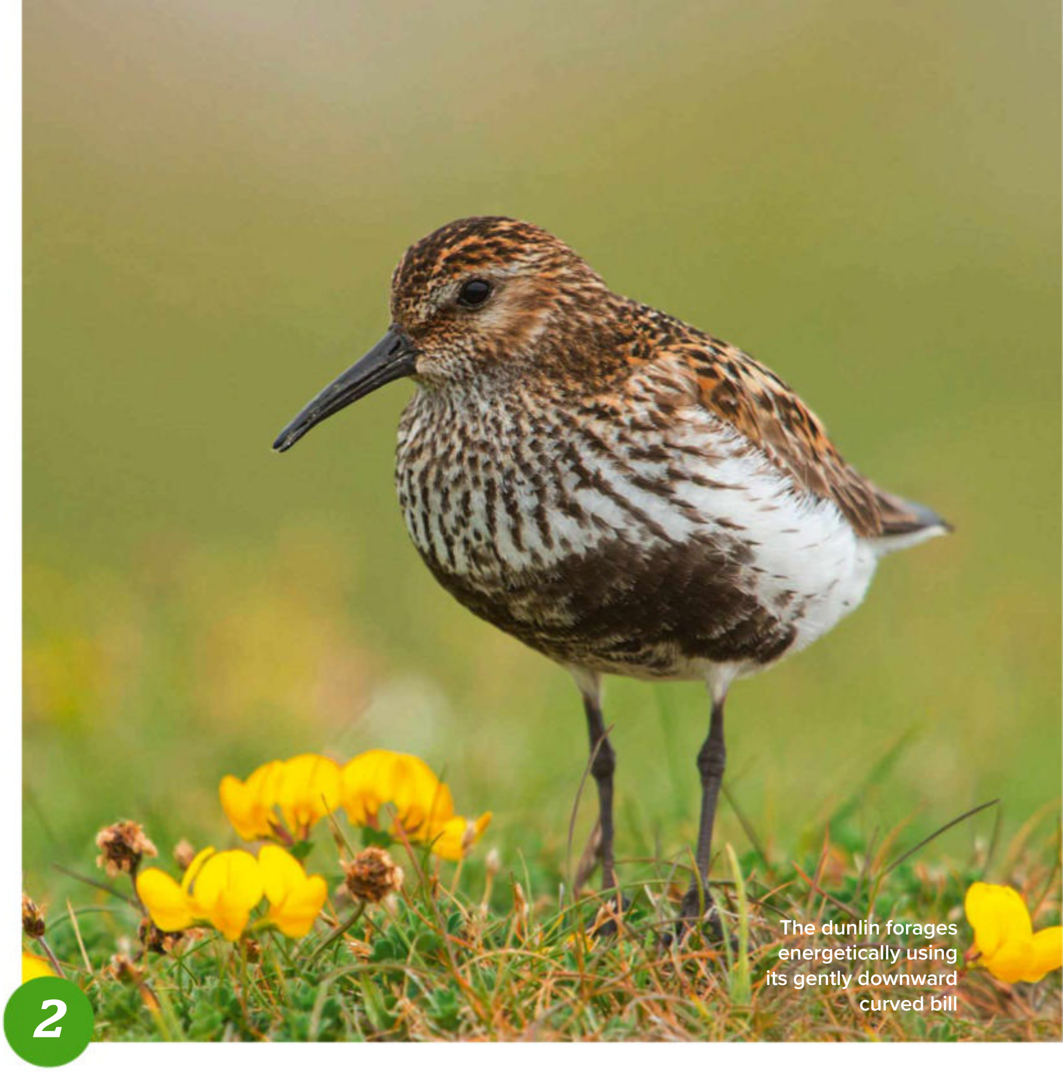
COME APRIL AND MAY, hedgehogs have no time to waste. If they're not foraging intensively to replace weight lost during hibernation, they are busy looking for mates and safe nesting sites. It's difficult to miss the moment a male and female hedgehog make more hedgehogs – the snuffles and grunts are quite loud. Hedgehogs do best in areas with a patchwork of open areas and shelter, one reason why gardens suit them.

All change

DUNLINS HAVE A SPLIT PERSONALITY. During winter, they are nondescript grey and white wading birds, abundant on muddy estuaries. To birders, they are the classic 'little grey job'. But in spring, these birds are very different beasts. Now wearing smart breeding plumage, featuring chestnut upperparts and a black belly patch, they abandon the coast and head north en masse to moors and bogs. Here, the males sing sweetly to set up their nesting territories, sometimes in mid-air, like skylarks.

As Mark Cocker points out in his book *Birds Britannica*, the dramatic seasonal change that dunlins go through flummoxed naturalists in the past – so much so that the 'summer dunlin' and 'winter dunlin' were long thought to be different species. Linnaeus actually gave them separate scientific names.

Though most dunlins migrate to the Arctic tundra to breed, a few thousand pairs nest in Britain. Many end up in the wild and remote Flow Country of northern Scotland, a peaty paradise that in 2024 finally became a World Heritage Site.



The dunlin forages energetically using its gently downward curved bill

2

3

Sylvan spectacle

APRIL SEES THE DAMP, HUMUS-RICH soil of ancient woods transformed into a scented sea of blue, as carpets of bluebells burst into flower (bluebells actually spend the majority of their time underground as bulbs). Western Britain is one of the best places in the world to breathe in this natural spectacle, and its bluebells appear to be flourishing due to the long-term trend of woods becoming shadier, with fewer gaps in the canopy (though these changes don't suit sun-loving plants, which are losing out).

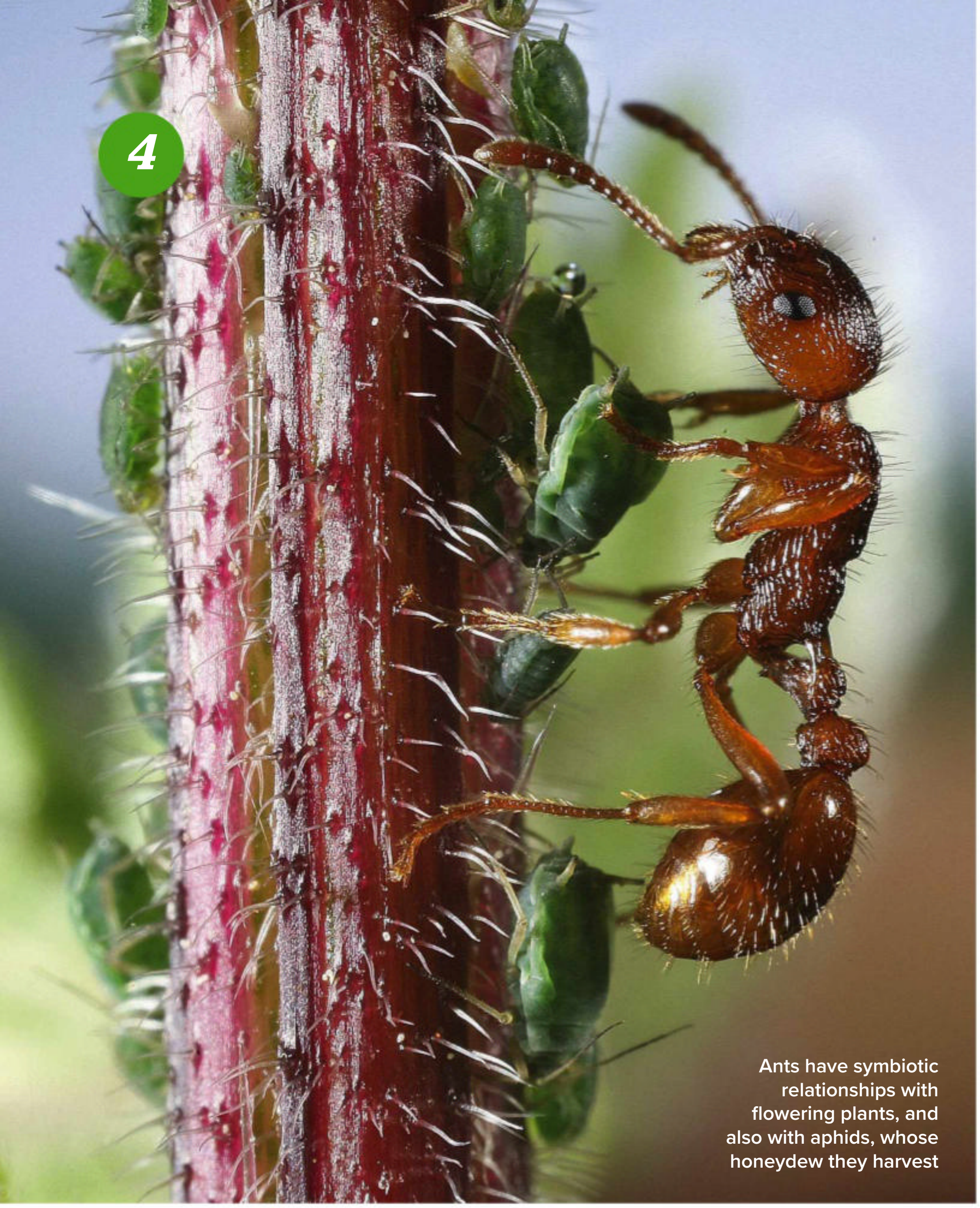
Another significant shift is that bluebells are flowering earlier. The date on which the first are spotted in bloom has moved forwards by at least 17 days this century, according to data gathered by citizen scientists for the Nature's Calendar project. Insects such as woodland butterflies, bees and hoverflies reap the benefits of this early flowering.

Take care to stick to the paths in a bluebell wood – don't be tempted to stray off-piste to get the perfect photo.

Bluebells are a useful clue that a woodland is ancient

HEDGEHOG: АЛЕКСЕЙ КОРНЕЕВ/ALAMY; DUNLIN: KEVIN HAZELGROVE/ALAMY; BLUEBELLS: ALEX HYDE/ALAMY

4



Ants have symbiotic relationships with flowering plants, and also with aphids, whose honeydew they harvest

Ant attraction

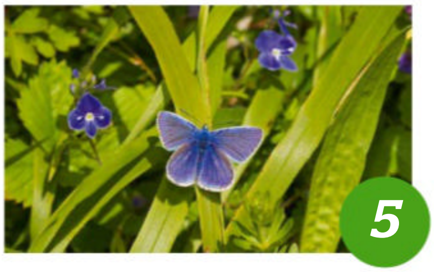
ALL OVER THE WORLD, ANTS HAVE developed symbiotic relationships with flowering plants, in which they transport the plants' seeds in return for a meal. There are many examples of this mutually beneficial arrangement in the British Isles. Several spring wildflowers are at it, including sweet and dog violets, primroses and cowslips.

These plants have special seeds with a blob of fat at one end, called an elaiosome. Ants find these fatty globules irresistible and go to a lot of trouble to find them. But the ants don't scoff their nutritious treasure on the spot – they take it back to the nest to feed their larvae.

Cowslips in the Peak District National Park

ABOUT THE AUTHOR

Ben Hoare is a wildlife writer, editor and all-round nature nerd. He also writes highly acclaimed illustrated natural history books for children.



5

Garden blues

From April to June, holly blue butterflies flit through sunny gardens, parks and woods, as if in a hurry. They're the only blue butterflies likely to be seen in these places. Widespread in England and Wales, they used to be rare north of the Lake District, but are fast spreading into Scotland.

6

Pass the salt

If you're travelling along a motorway or dual carriageway this spring, you might notice lots of little white flowers on the roadside and central reservation. This is Danish scurvy grass, a salt-loving coastal plant that has colonised the strips of 'inland saltmarsh' created by road salting.

7

Sea swallows

Throughout April, groups of Sandwich terns can appear on almost any British shore, as they migrate to the handful of islands and headlands where they breed. These elegant 'swallows of the sea' will return south in September to their wintering areas on the coast of West Africa.

RED ANT: KIM TAYLOR/NATUREPL.COM; COWSLIP: ALEX HYDE/NATUREPL.COM; BUTTERFLIES: ROD WILLIAMS/NATUREPL.COM; SCURVY GRASS: NIGEL SAWYER/ALAMY; SANDWICH TURN: GRAHAM EATON/NATUREPL.COM

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Humans have often acted as keystone species

OPINION

GILLIAN BURKE

“Losing sight of this version of the human story hurts us all in the end”

“THE MAASAI WORD ‘SERENGETI’ means endless plains,” says broadcasting’s most reassuring voice. “Back then,” he continues, “it seemed inconceivable that we, a single species, might one day have the power to threaten the very existence of the wilderness.”

In 2020, I had the honour of hosting the launch of Sir David Attenborough’s film, *A Life on Our Planet*, a look back at an extraordinary life that, sadly, has also witnessed the worst collapses of biodiversity and habitat loss because of human activity.

Speaking over grainy, black and white film footage, as the shadow of a single prop aircraft skims across the savannah, Attenborough’s voice takes us back to his first visit to East Africa in 1960. “You could be forgiven for thinking that these plains are endless,” he narrates, going on to say, “It took a visionary scientist, Bernhard Grzimek, to explain this wasn’t true.”

German zoologist and film-maker Grzimek flew his iconic zebra-patterned plane over an area that is now recognised as the wider Mau-Mara-Serengeti complex. There is no doubt that, like Attenborough, Grzimek was captivated by the breathtaking wilderness as he charted the migration patterns of vast herds of animals that cross the savannah. As I watched the film, I had a quiet nagging feeling, but it was quickly drowned out by the noise of the biggest gig of my professional life.

Recently, I have been researching my family history and the nagging finally came home. My grandfather was born in the West Indies, but headed east, first to London where he was called to the bar, then to British East Africa in the 1930s, where he practised as the first black barrister.

Court documents and newspaper articles all point to a busy life travelling between the administrative posts of Nairobi, Naivasha, Narok and Arusha – criss-crossing the same ‘endless plains’ that Attenborough and Grzimek would visit decades later. Certainly, the nomadic Maasai, who my grandfather represented in court, would have been well-acquainted with seasonal and migration patterns and the true extent of their ancestral land, long before any of these men arrived.

I’ve always had an unease about the way we talk about wildlife and nature in the wildlife film industry, as if in a vacuum divorced from any historical, cultural or indigenous context. But this time, I got a taste of the pain that comes from being overlooked, while standing in plain sight.

Dr Lyla June Johnston, of the Diné Nation, who has studied human ecology at Stanford University, talks about the ‘erasure’ of indigenous knowledge systems, where humans have often acted as keystone species, increasing biodiversity and abundance through their activity.

Losing sight of this version of the human story hurts us all in the end, leading many to the mistaken belief that ‘the Earth would be better off without humans’.

Removing humans from the scene in our natural history films and nature writing, except to highlight the damage done, leaves us with nowhere to go except to internalise an unshakable belief that our species is inherently bad for the planet.

Dr Johnston joins other ethnoecologists in highlighting a long, indigenous tradition of humans as keystone species, from a pre-Industrial English orchard to managing landscapes through indigenous cultural burning in Australia, California and, indeed, even in the endless plains of the Serengeti.

The time is long overdue to flip the script, even in the face of overwhelming evidence, so we can begin to imagine a better version of our species.

Gillian Burke is a biologist, writer, film-maker, presenter and podcaster. She was part of the BBC Two *Watches* team from 2017-2025.

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FEMALE OF THE SPECIES

SUPERB LYREBIRD

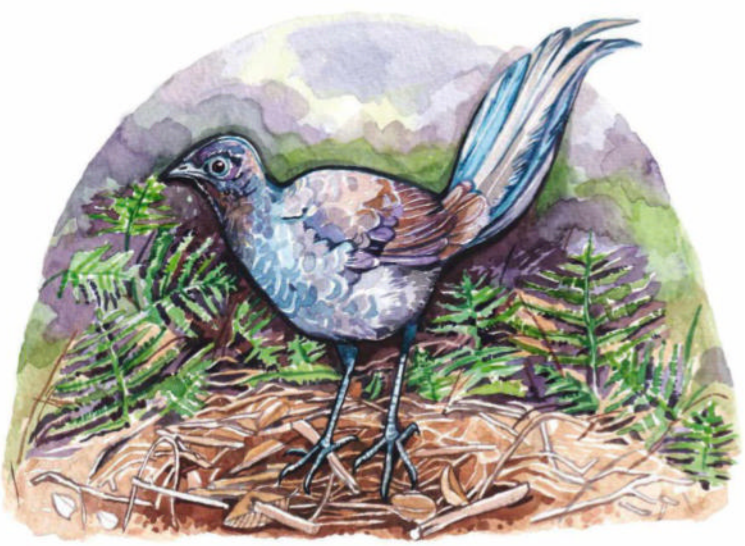
These ladies have a voice – and a taste for vandalism

THE MALE SUPERB lyrebird (*Menura novaehollandiae*) is a king of avian karaoke, notorious for his vocal mimicry. A clip from David Attenborough's *The Life of Birds,* featuring a lyrebird riffing on a chainsaw, kookaburra and car alarm, has been viewed on YouTube more than 22 million times. We're told the lyrebird's extraordinary skills evolved in his quest for mates. What's not mentioned is that the lyrebird's paramour shares these mimetic skills. Females are capable of freestyling their own complex songs but, until recently, no humans had noticed.

There has been a longstanding androcentric bias in birdsong study, dating back to Darwin. The melodious calls of songbirds such as the superb lyrebird are a textbook example of sexual selection: a male ornament evolving to be ever more elaborate over generations of male competition and female choice.

Much like Victorian ladies at a dinner party, female songbirds had no reason to compete. Hushed by Darwin's theory, their role was simply to listen to the jazzy showmanship of the cocks and reward their favourites with sex. Females caught singing were written off as babbling freaks. Their calls fell on deaf scientific ears, brushed aside with excuses: female vocalisations were the result of a 'hormonal imbalance' or simply a non-adaptive by-product of shared development with the male.

This was the story with the female superb lyrebird until Anastasia Dalziell, leader of Australia's Lyrebird Lab, heard different. In 2014, out in the field, she noticed a series of distinct lyrebird calls, which she tracked back to females. Though lyrebird females could be mistaken for immature males, Dalziell recognised their sex from their wonky tails, bent from hours of nest-sitting.



It had long been thought that only the male superb lyrebird was capable of vocal mimicry but the female is an equally capable crooner

Dalziell started tracking females and discovered they're capable of sophisticated mimetic vocalisations. She counted 20 different species being impersonated and a host of other noises, some not even vocal, such as the sound of tree branches rubbing in the wind and the beating of bird wings.

Unlike the male, their songs haven't evolved to attract mates but to prevent rival females from stealing their territories and vandalising their nests.

Female superb lyrebirds are fiercely competitive. They'll viciously attack their neighbours' nests, which explains why they go to the effort of building more than one, to confuse their rivals and protect their offspring. Dalziell suspects vocal mimicry may have evolved for similar reasons. She recorded nesting females aping the calls of a grey goshawk, a known lyrebird predator. Crying wolf would deter rivals and keep chicks safe.

The lyrebird joins other female songbirds, such as the house wren, that also use complex vocalisations to protect their nests. These avian divas are challenging fundamental assumptions about birdsong evolution.

Thanks to a consortium of feminist scientists, we now know that more than 70 per cent of female songbirds sing. This revelation is likely a factor of geographic bias as much as androcentrism. Songbirds were traditionally studied in the northern hemisphere, where females tend to be less vocal. It's a different story in Australia, where most female songbirds, like the lyrebird, are backyard belters. Given that songbirds evolved in Australia some 47 million years ago, it's believed that females always sang. So, the question Darwin might have asked, down under, is not why males sing but why have some females lost their voices.

Lucy Cooke is a broadcaster, zoologist and author of *Bitch: What Does It Mean To Be Female?* The Penguin paperback is on sale now.

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Catch up with Lucy's three-part BBC Radio Four series, *Political Animals*

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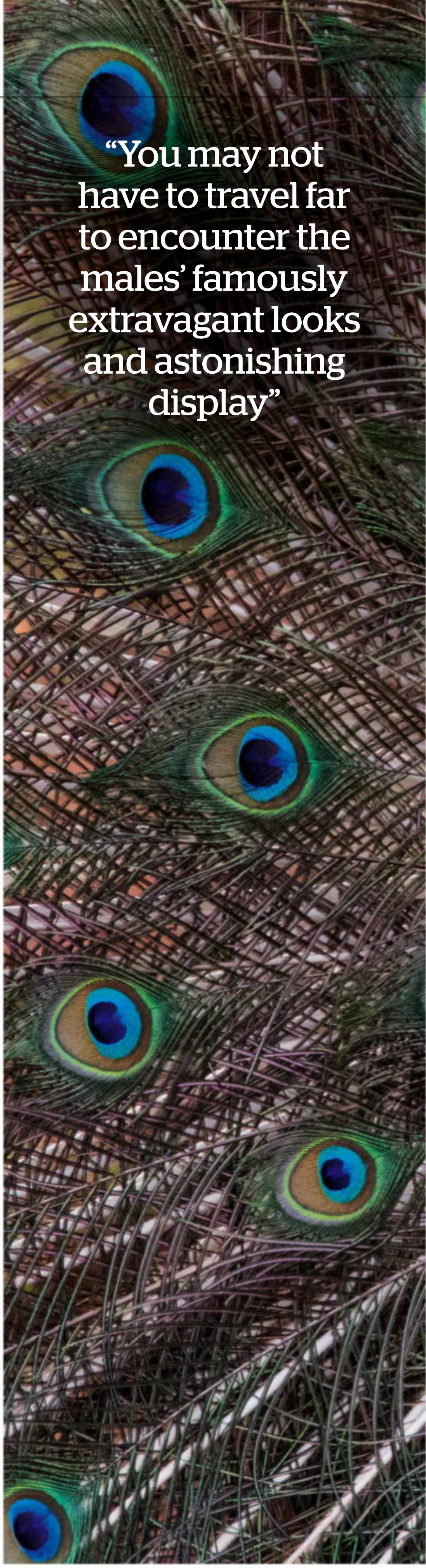
WILDLIFE SPECTACLES

The broadcaster, naturalist and tour guide shares the most breathtaking seasonal events in the world

SHAKE IT OFF

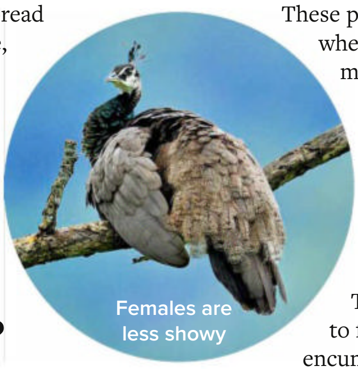
DISPLAYING INDIAN PEAFOWL

When it comes to impressing the females, peacocks know how to put on a show



"You may not have to travel far to encounter the males' famously extravagant looks and astonishing display"

IF YOU WERE TO RANK THE 11,276 BIRDS currently known on Earth on a scale of recognisability, the Indian peafowl surely deserves a place in the top 10. In the wild, peafowl are found across most of the Indian subcontinent, including Sri Lanka. But thanks to widespread introductions across Europe, the Antipodes, the USA and South Africa, you might not have to travel too far to catch up with the males' extravagant looks and astonishing display.



Females are less showy

Being a sexually dimorphic species, the males (peacocks) are very differently plumed to the females (peahens). Sporting an electric-blue neck and head, topped with a small crest, the male is best known for his impressive train, which extends for more than a metre beyond his rump.

These plumes are only fully formed when the males reach sexual maturity, at around three years of age, and are in fact elongated upper tail covert feathers.

They contain a multitude of colourful eyespots and terminate in a distinctive fishtail. The males are still able to fly, despite the obvious encumbrance, but usually only do so when heading into their lofty tree-roosts at dusk.

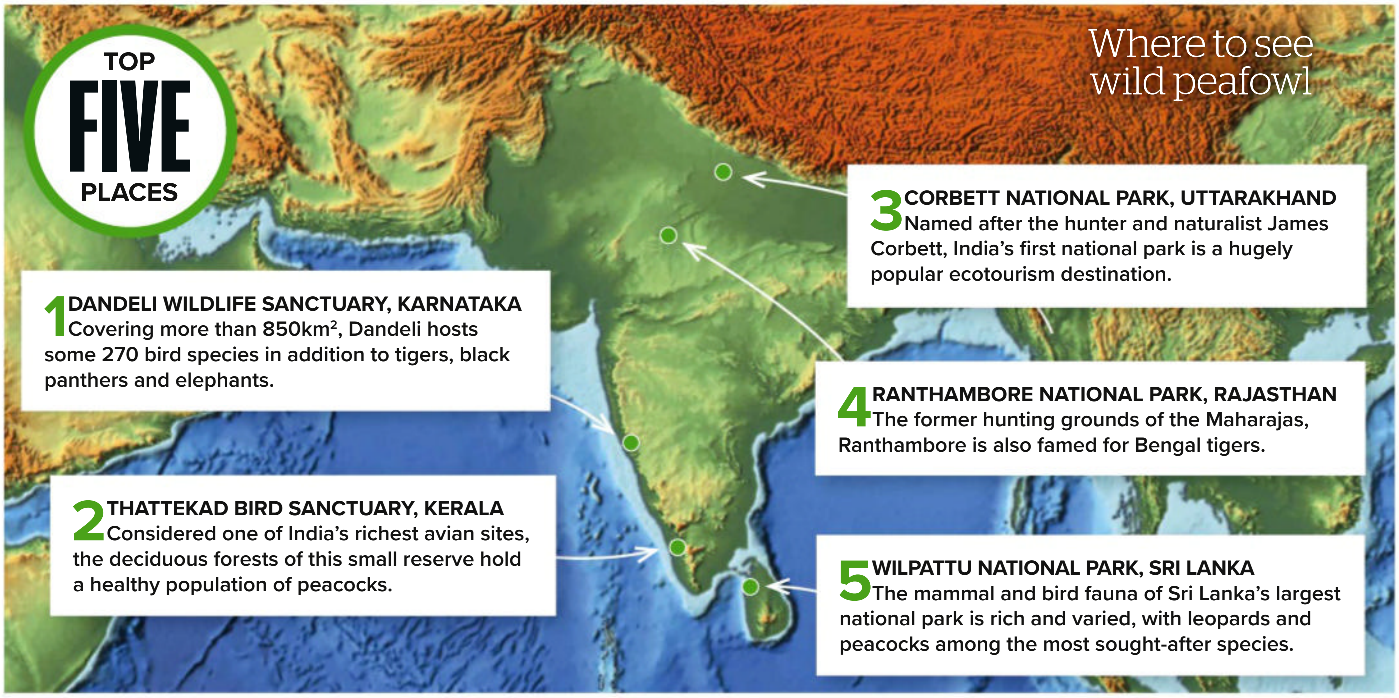
The females, in contrast, lack this elaborate accessory and are predominantly brown, which helps them to safely blend

Did you know?

Peacocks are noisy birds, known for their brash 'may-oooow' call, which carries for long distances. The birds tend to call in the early morning and evening, ramping up the racket during the breeding season.

MALE PEACOCK: LUCAS BUSTAMANTE/NATUREPL.COM; FEMALE: SAFIQUE/GETTY

A peacock raises its ornate tail feathers, engaging its display mode



Where to see wild peafowl

TOP FIVE PLACES

1 DANDELI WILDLIFE SANCTUARY, KARNATAKA
Covering more than 850km², Dandeli hosts some 270 bird species in addition to tigers, black panthers and elephants.

2 THATTEKAD BIRD SANCTUARY, KERALA
Considered one of India's richest avian sites, the deciduous forests of this small reserve hold a healthy population of peacocks.

3 CORBETT NATIONAL PARK, UTTARAKHAND
Named after the hunter and naturalist James Corbett, India's first national park is a hugely popular ecotourism destination.

4 RANTHAMBORE NATIONAL PARK, RAJASTHAN
The former hunting grounds of the Maharajas, Ranthambore is also famed for Bengal tigers.

5 WILPATTU NATIONAL PARK, SRI LANKA
The mammal and bird fauna of Sri Lanka's largest national park is rich and varied, with leopards and peacocks among the most sought-after species.

into their surroundings while incubating their clutches and rearing young.

The Indian peafowl is found in a range of habitats, including deciduous forest, scrubland and grassland. It is omnivorous by nature and mostly forages on the ground for seeds, fruits, insects, small reptiles and a range of crops. The bird also lives alongside cultivated land and, in this scenario, often ends up existing in a semi-domesticated state.

Usually encountered while foraging or resting during the heat of the day, peafowl groups usually consist of either cocks or hens. This dynamic quickly changes with the advent of the breeding season, when groups become mixed.

Males, in an attempt to form a hierarchy at specific lekking sites, initially display to one another, but save most of their energy for the hens. When a female arrives, they leap into action, raising their tails into giant fans. They also appear to orient their bodies towards the sun, to ensure their iridescent head, neck and train feathers are shown off in the best possible light. For their pièce de résistance, the suitors noisily shake or vibrate their fanned tails to mesmeric effect.

Peacocks can fly for short distances, usually when heading into their evening tree-roosts

> "For their pièce de résistance, the males shake their tails to mesmeric effect"

One study of peafowls has revealed that only the fittest males are able to maintain a long tail, so an impressive train must indicate good body condition, ultimately resulting in greater mating success. Subsequent research that involved tracking the hens' eye movements during the males' display also revealed that the females appear fixated with the upper train at a distance, while their attention becomes more focussed on the lower feathers at closer quarters. And the 'shaking their tail feathers' element is believed to ensure the females' attention doesn't wander during the performance, perhaps to rival males waiting in the wings.

So celebrated is this behavioural spectacle that the peacock was even used by Charles Darwin as a textbook example of sexual selection. In essence, for males to be considered an evolutionary success, they must not just survive but survive long enough to find a mate and reproduce. But since it is ultimately the females that choose who they mate with, the males are forced along the 'ever-more-fancy-tail' route, even if this increases their chance of falling victim to predators.

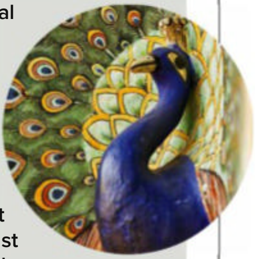
For the males so desperate to pass on their genes, a large, cumbersome tail is clearly a risk worth taking – and also the reason why this species is venerated far beyond its native shores.

LOOK CLOSER

Peafowl trio

There are three species of peafowl: the Indian peafowl; the closely related green peafowl from the tropical forests of south-east Asia; and the more distantly related Congo peafowl. The latter two are threatened by habitat loss and hunting.

A cultural icon



The Indian peafowl has been recognised as the national bird of India since 1963, yet its significance to the country's art, literature and religion stretches back thousands of years. Jaipur's Peacock Gate (*right*) and Peacock Temple, just outside Bangalore, are just two examples of incredible peacock-related art.

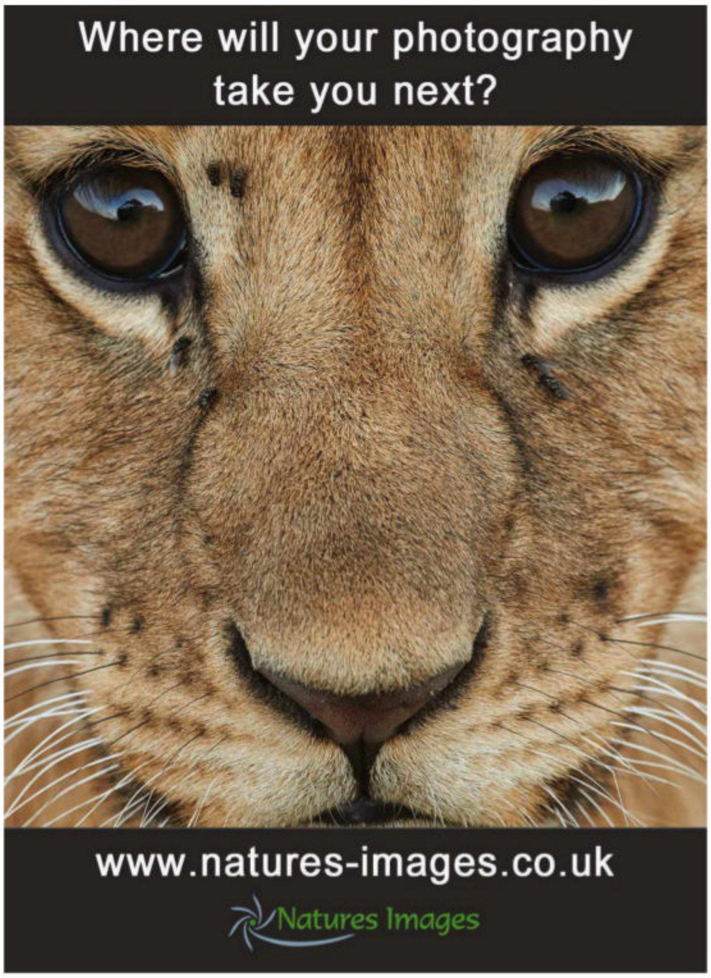
Look into my eyes...

The peacock's iridescence is due to the physical properties of its feathers, rather than pigments. The feathers contain microscopic barbules coated in crystal-like structures, and create colour by reflecting specific wavelengths of light from the visible spectrum. This means a peacock's feather colour will never fade.

NEXT MONTH

A bloom of jellyfish in Palau, Indonesia

PEACOCK IN FLIGHT: PATRICIO ROBLES GIL/NATUREPL.COM; STATUE: JEREMY VILLASIS/GETTY; GOLDEN JELLYFISH: DESIGN PICS INC/ALAMY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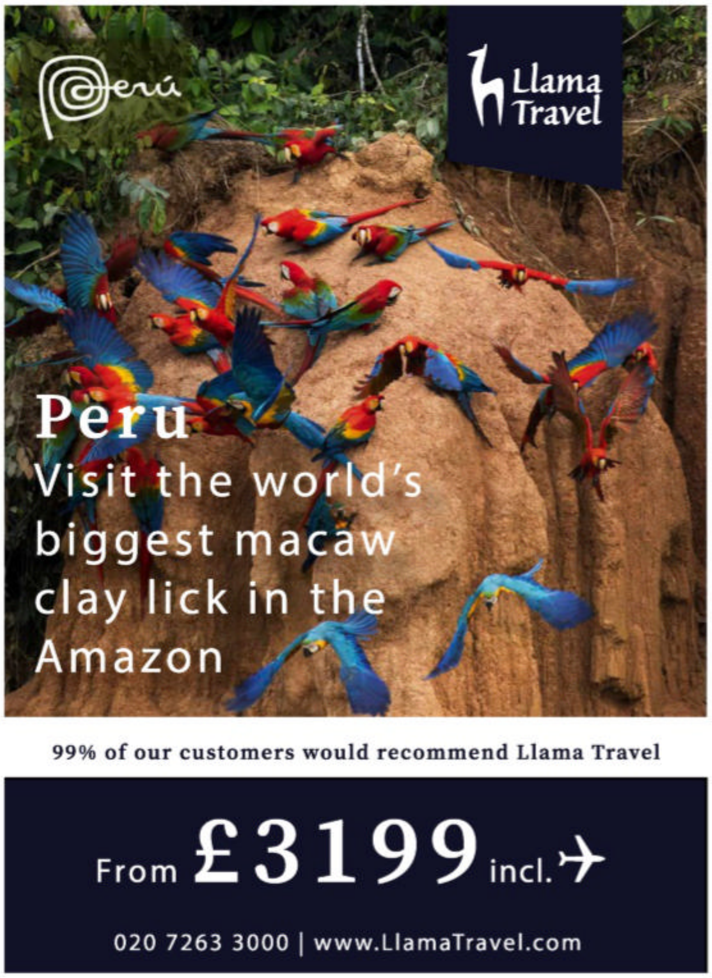
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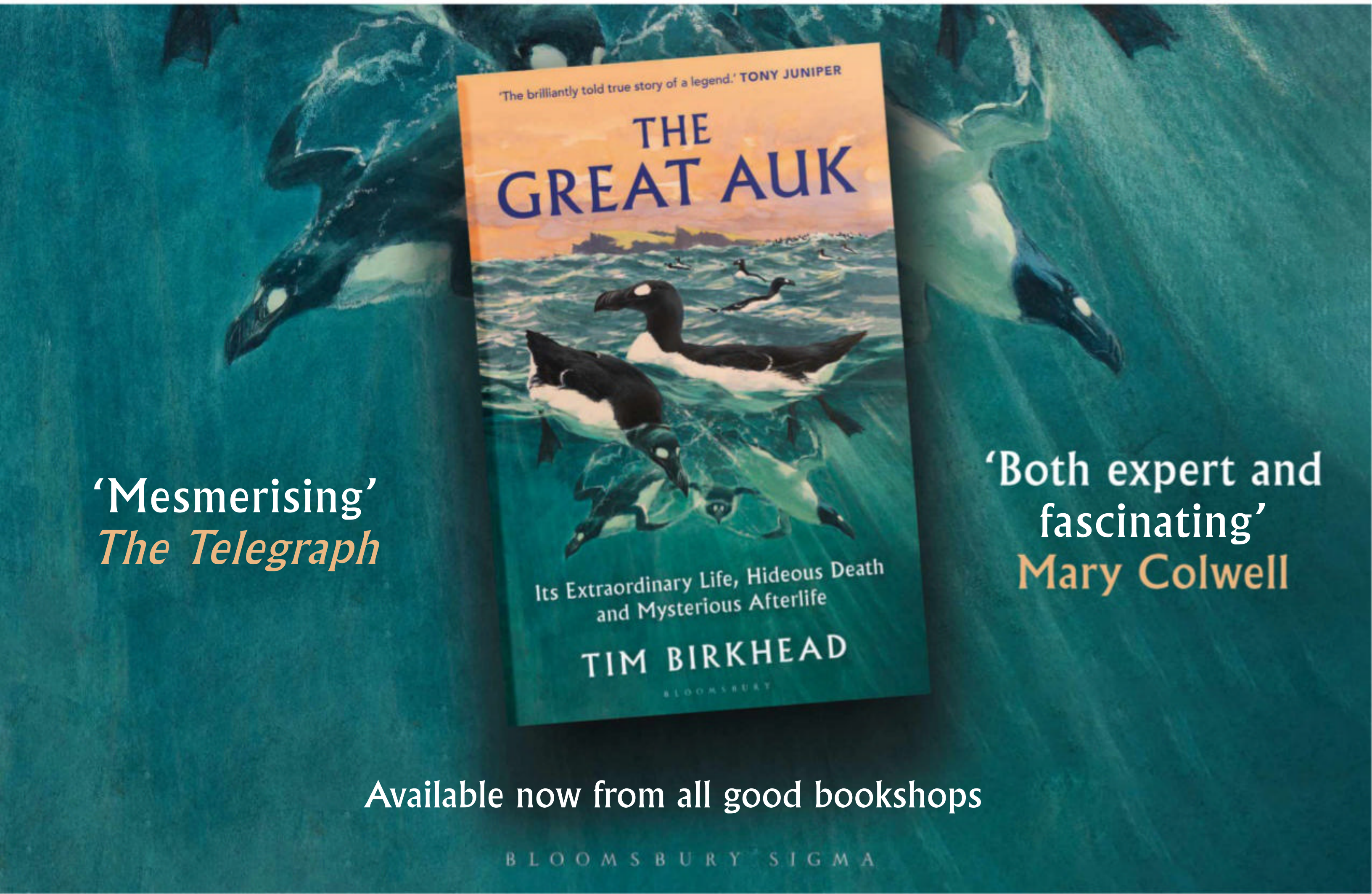
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CIRCLE IN THE SAND

SANDGROPER

The seldom-seen subterranean insect that swims beneath our feet

IT LOOKS LIKE A SMALL CHIPOLATA SAUSAGE to which some joker has tastelessly attached the front end of a mole cricket. This apparent chimaera of a creature, however, is real. The sandgroper is a kind of grasshopper and is seriously good at surviving in Australia's harsh and arid sand-lands. The 14 species are collectively known by the rather descriptive scientific name, Cylindrachetids. Some are quite large, growing to 7-8cm long, but sandgropers are rarely seen and, given their highly specialised subterranean lifestyle, this isn't much of a surprise.

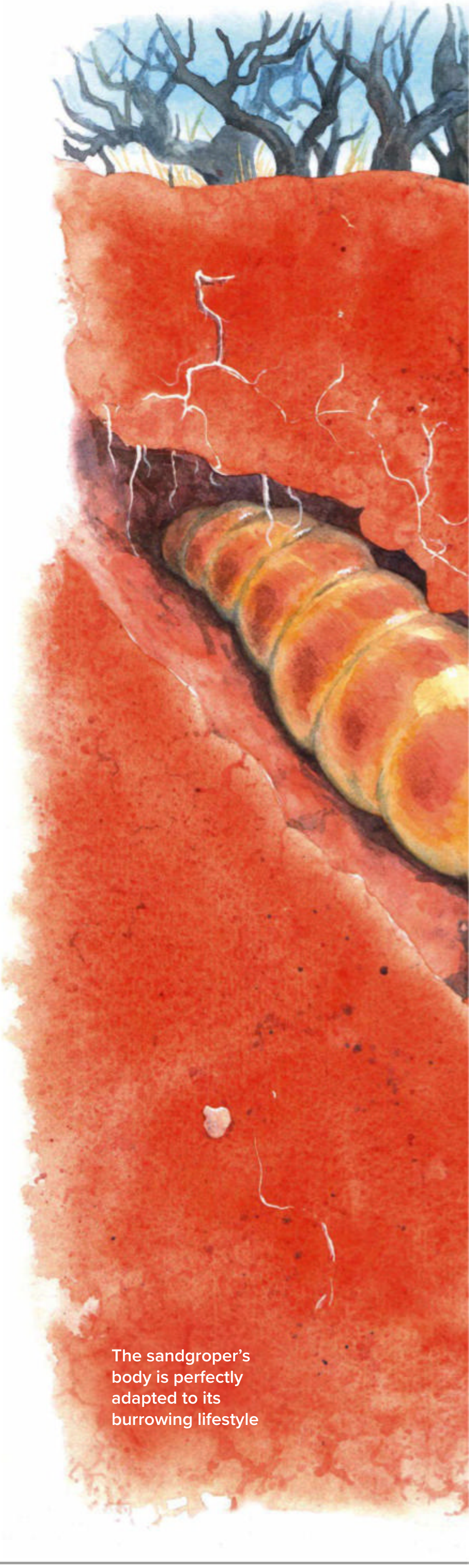
They are peculiar to look at because everything about them is honed to their hypogean ways beneath the sand's surface. Here they can shelter, avoid predators and find cooler, more humid conditions away from the dehydrating effects of the sun and wind. It's a good gig if you can handle the challenges of living in an ever-changing, shifting and abrasive habitat.

The sandgroper has a long, lithe body, a bit like a subway train, which presents as little frontal area to the sandy soil as possible. Its 'engine' at the front end drags behind it the 'carriage' of its soft, elongated abdomen. The head and thorax are terra-dynamic (it's a thing), tough and shiny. The pointed head-capsule, short antennae and almost non-existent eyes all help to reduce resistance to the substrate it burrows through. But it is those front legs, looking like ears on a worm, that catch the eye.

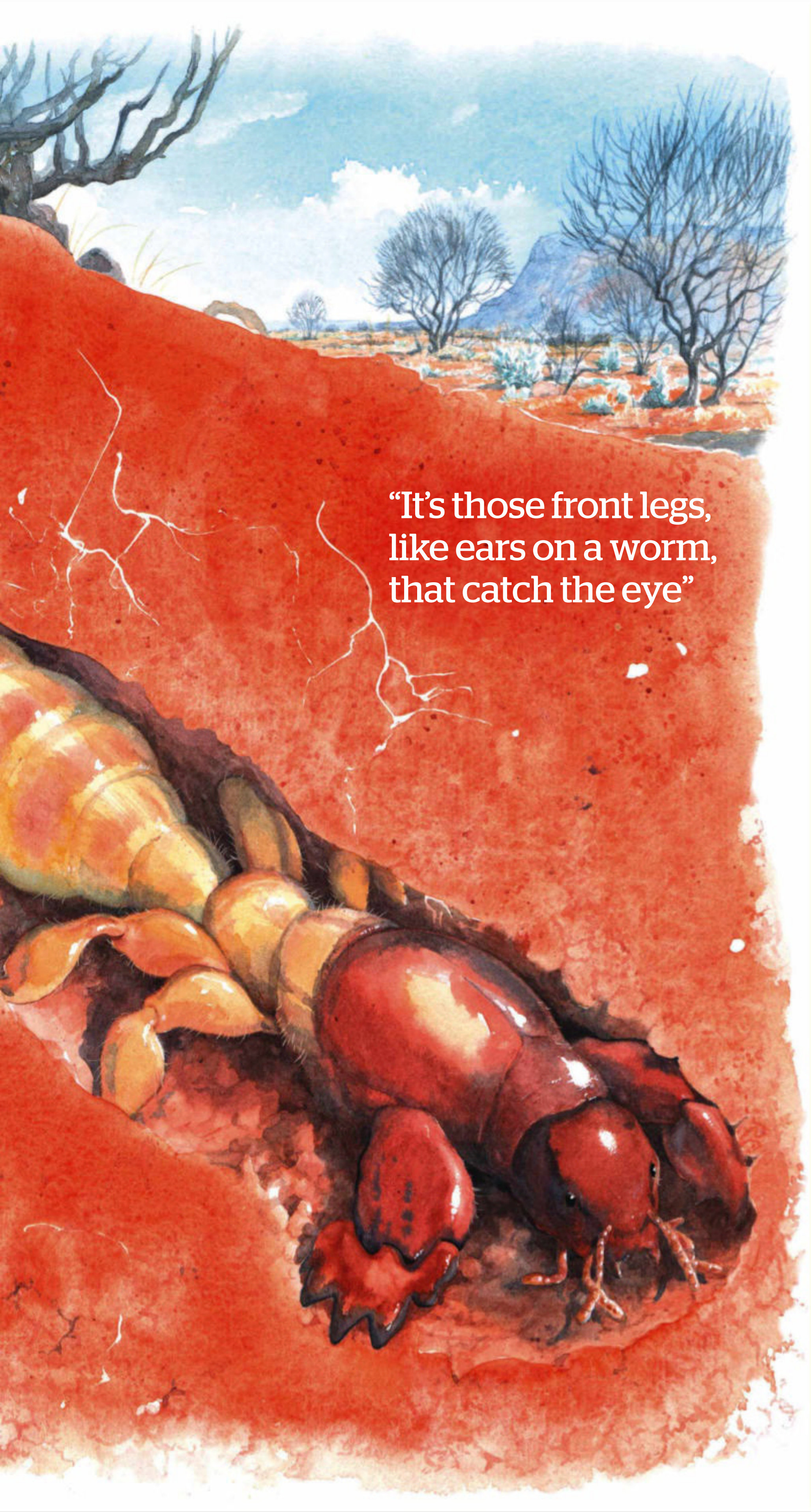
They are analogous to those of a mole – short, strong and powerful. What is missing are those little foot segments or 'tarsi' found at the ends of the legs of most insects. In sandgropers these limbs are reduced to the first pair of segments, which are shortened and flattened to form highly effective shovels.

The other two pairs of legs, complete with eye-catching pale patches that look like beads, are similarly reduced and unlike the limbs of any grasshopper. There are also no jumping legs at the rear. Instead, the last two pairs of legs recess into depressions in the sides of the insect's thorax. Here, they can be tucked away when not being used to drag the insect to and fro in its tunnel.

For an entomologist, many of these features echo those found in mole crickets (another specialised burrowing insect), and it's tempting to conclude they're related. But



The sandgroper's body is perfectly adapted to its burrowing lifestyle



“It’s those front legs, like ears on a worm, that catch the eye”

a closer look reveals that sandgropers have short antennae compared to the long ones of mole crickets; the latter also have wings.

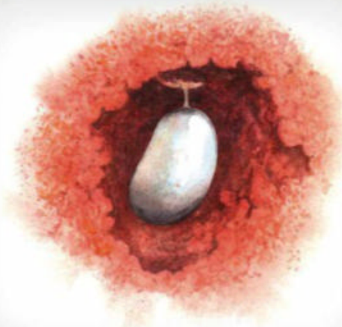
What the sandgroper exhibits is a fabulous example of nature independently finding its best solution to a specific set of environmental challenges in two groups of unrelated animals – something called convergent evolution.

Sandgropers are compression burrowers, forcing sand particles out of their path using their front limbs in a kind of breast-stroke action. In loose sand they literally swim through, but in slightly firmer ground they form tunnels and galleries. After rain, the surface tunnelling efforts of the males (perhaps looking for females) leave characteristic raised ridges on the surface of the sand – one of the few clues to their existence.

For the rest of their lives, they remain in their underworld. Despite the paucity of records for the 14 or so known species, the reality suggests they can exist in large numbers under our very feet. Excavations down a couple of metres have revealed an astonishing count of around 100 for every square metre of sand surface.

Despite being blamed for damaging crops and grassland in Western Australia, little is known about the sandgroper’s diet. Gut analysis of a few suggests they are omnivorous, eating a mixture of plant material and other invertebrates. They are even partial to a bit of cannibalism, if the opportunity presents itself.

LOOK CLOSER



An egg dangles in its chamber

Hung up

Unlike regular grasshoppers, which lay clusters of small eggs, sandgropers develop from large eggs that are laid individually, each within its own cell, suspended by a thread. Eggs are white, pink or deep red and relatively large – up to 7mm long. Development is slow and the sandgroper’s life-cycle extends over several years.

ILLUSTRATIONS BY PETER DAVID SCOTT/THE ART AGENCY

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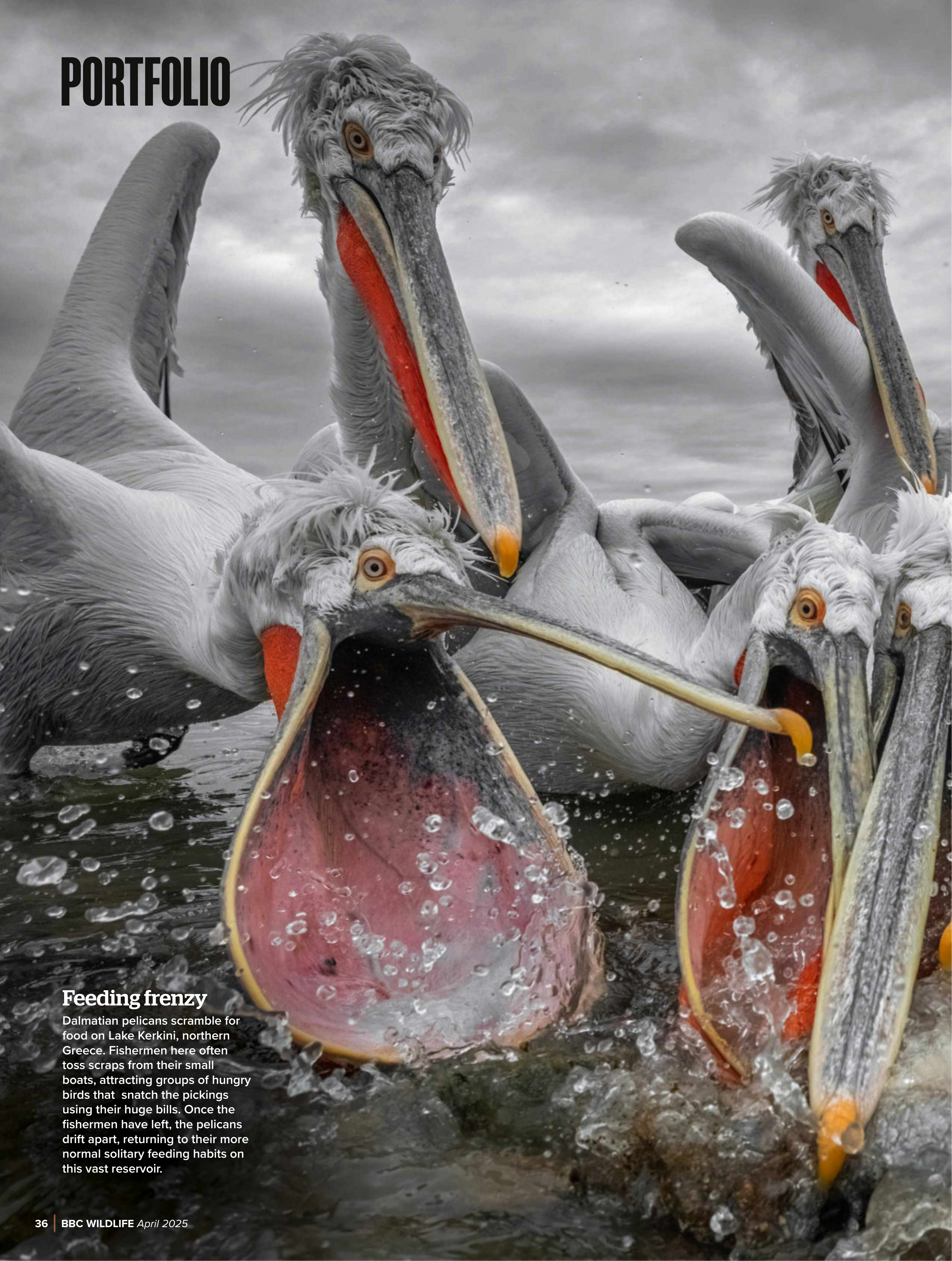


Feeding frenzy

Dalmatian pelicans scramble for food on Lake Kerkini, northern Greece. Fishermen here often toss scraps from their small boats, attracting groups of hungry birds that snatch the pickings using their huge bills. Once the fishermen have left, the pelicans drift apart, returning to their more normal solitary feeding habits on this vast reservoir.

FISHER KINGS

Some of the world's biggest birds gather to feast at a tranquil lake teeming with fish in the mountainous north of Greece

Photos by **GUY EDWARDES**
Words by **JOE PONTIN**

Winged giant

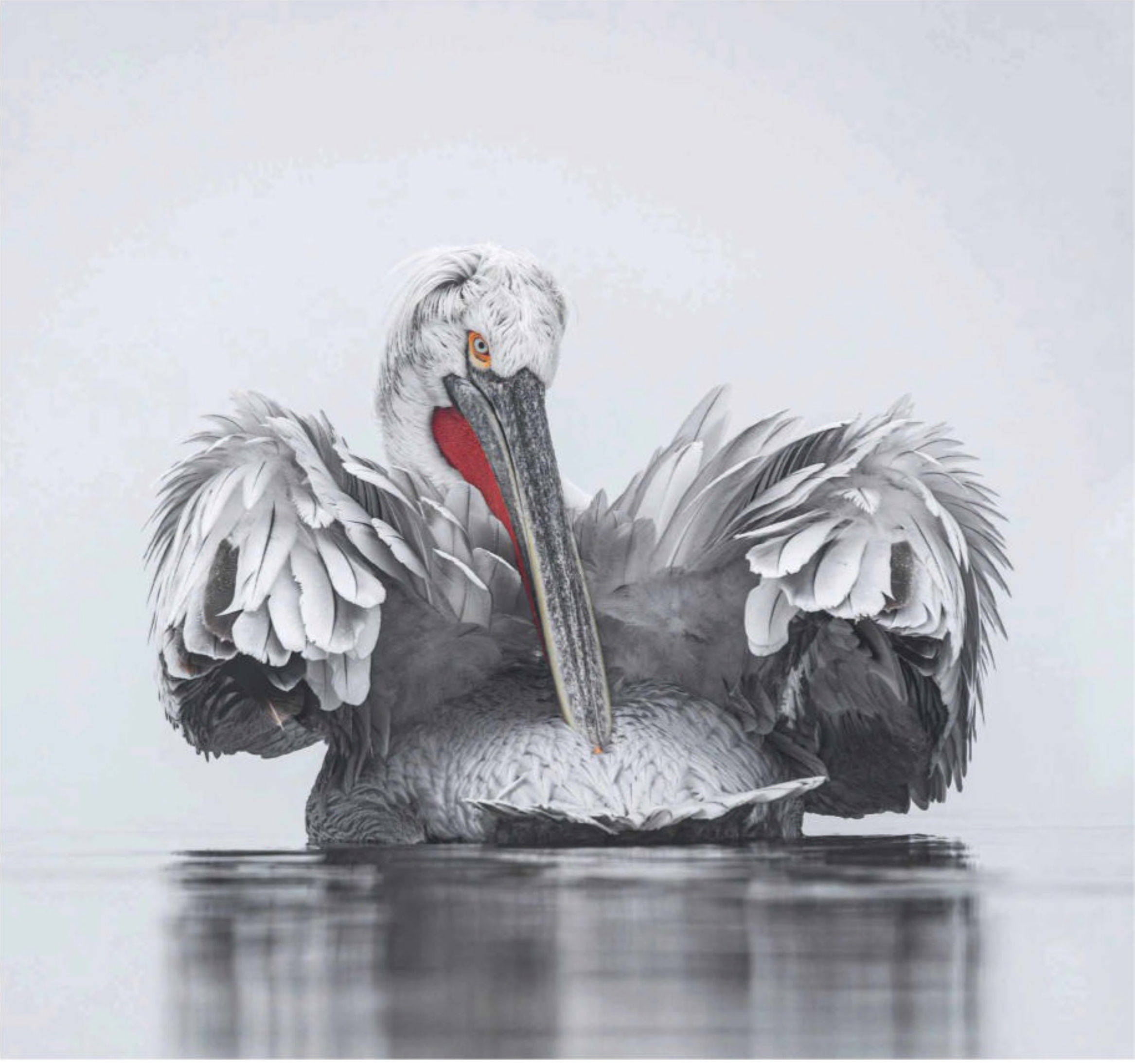
Weighing up to 15kg, the Dalmatian is the largest pelican species and one of the heaviest of all flying birds. Considering its size and weight, the bird looks elegant in flight, insists photographer Guy Edwardes – especially when the wind assists its aerial manoeuvres.

ABOUT THE PHOTOGRAPHER

Based in Dorset, Guy Edwardes is a wildlife and landscape photographer who specialises in the wildlife of the British Isles. He also runs photography workshops and is author of *100 Ways to Take Better Nature & Wildlife Photographs*.

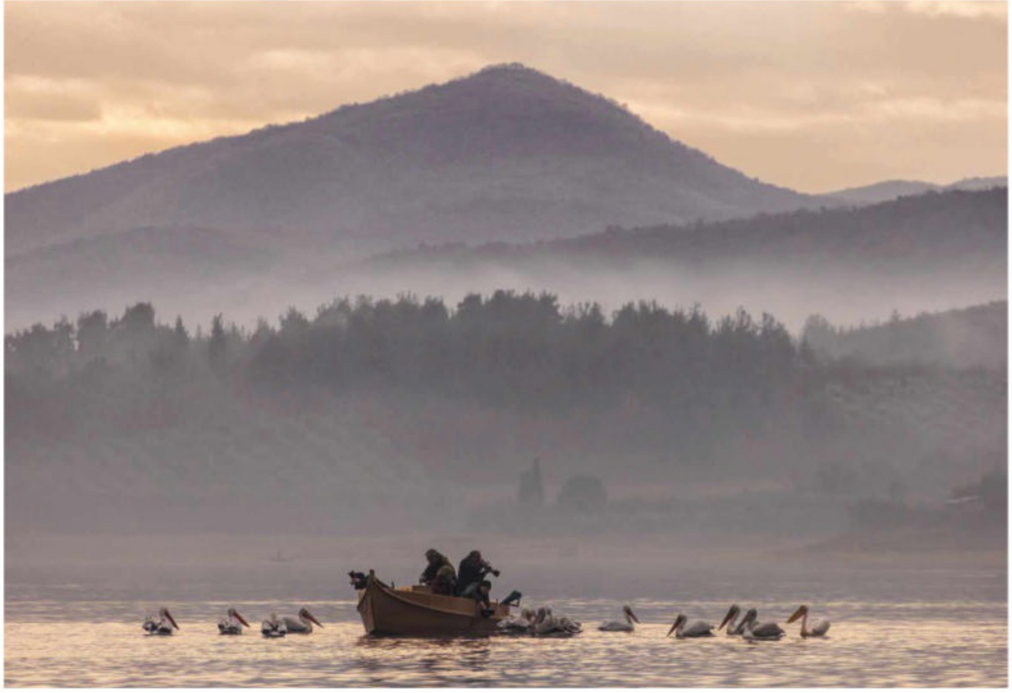
Red hot

In January and February, the pelican's throat-pouch turns from dull yellow to orange and then, as the breeding season approaches, to a deep crimson. According to Guy, around 300 Dalmatian pelicans are usually present on Lake Kerkini in winter. Of these, about 100 pairs breed there.



Feather finery

The Dalmatian pelican spends a large part of its day preening. The bird uses its bill to extract oil from its uropygial gland, near the base of its tail, and to brush the oils into its feathers, keeping them waterproof, flexible and durable.



A special relationship

On Lake Kerkini, the Dalmatian pelican is much more tolerant of people than in many other locations – but only on the areas of the water it associates with fishers, says Guy. Here, the birds gather around photographers in a boat, hoping to be fed.

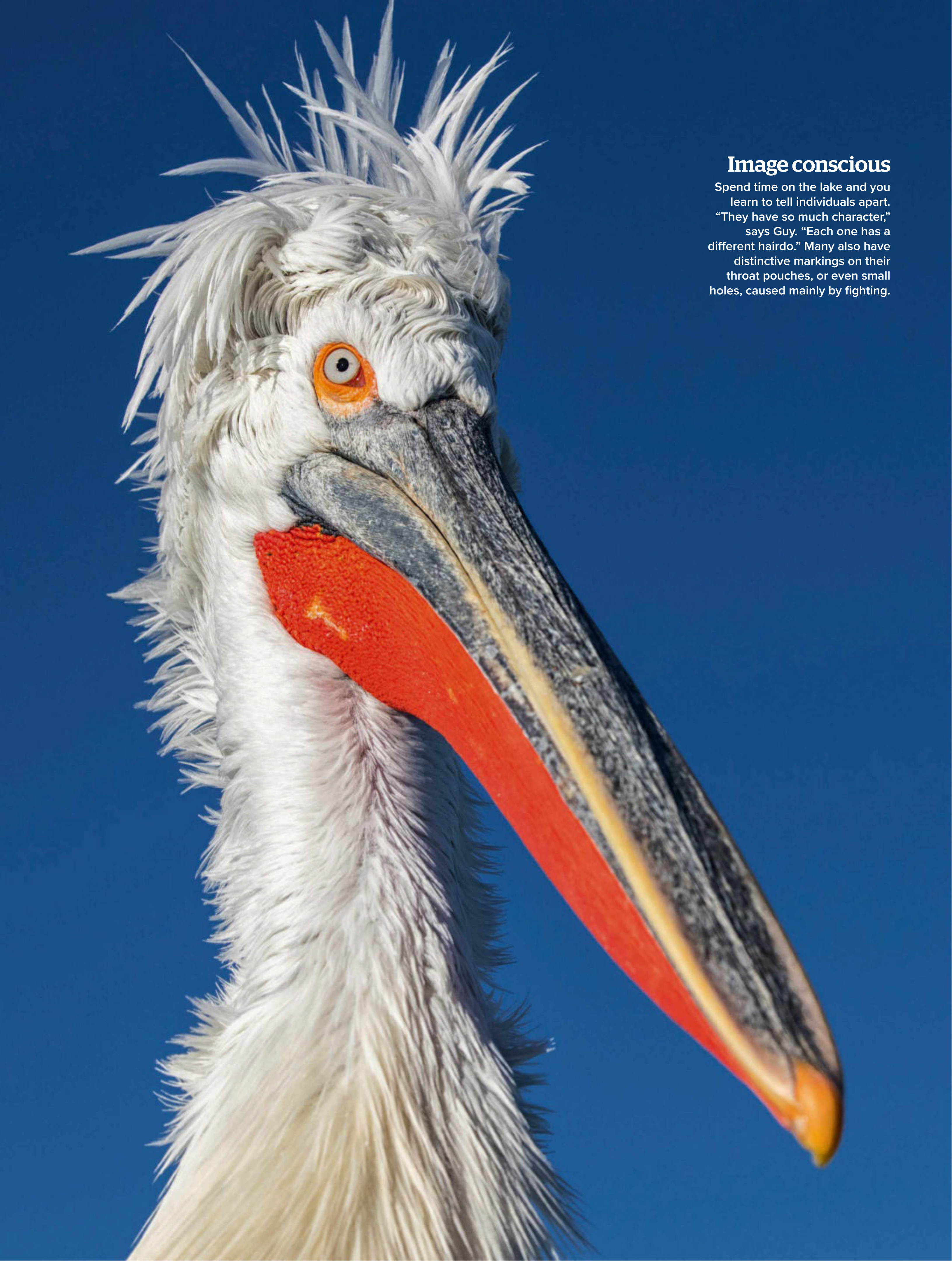
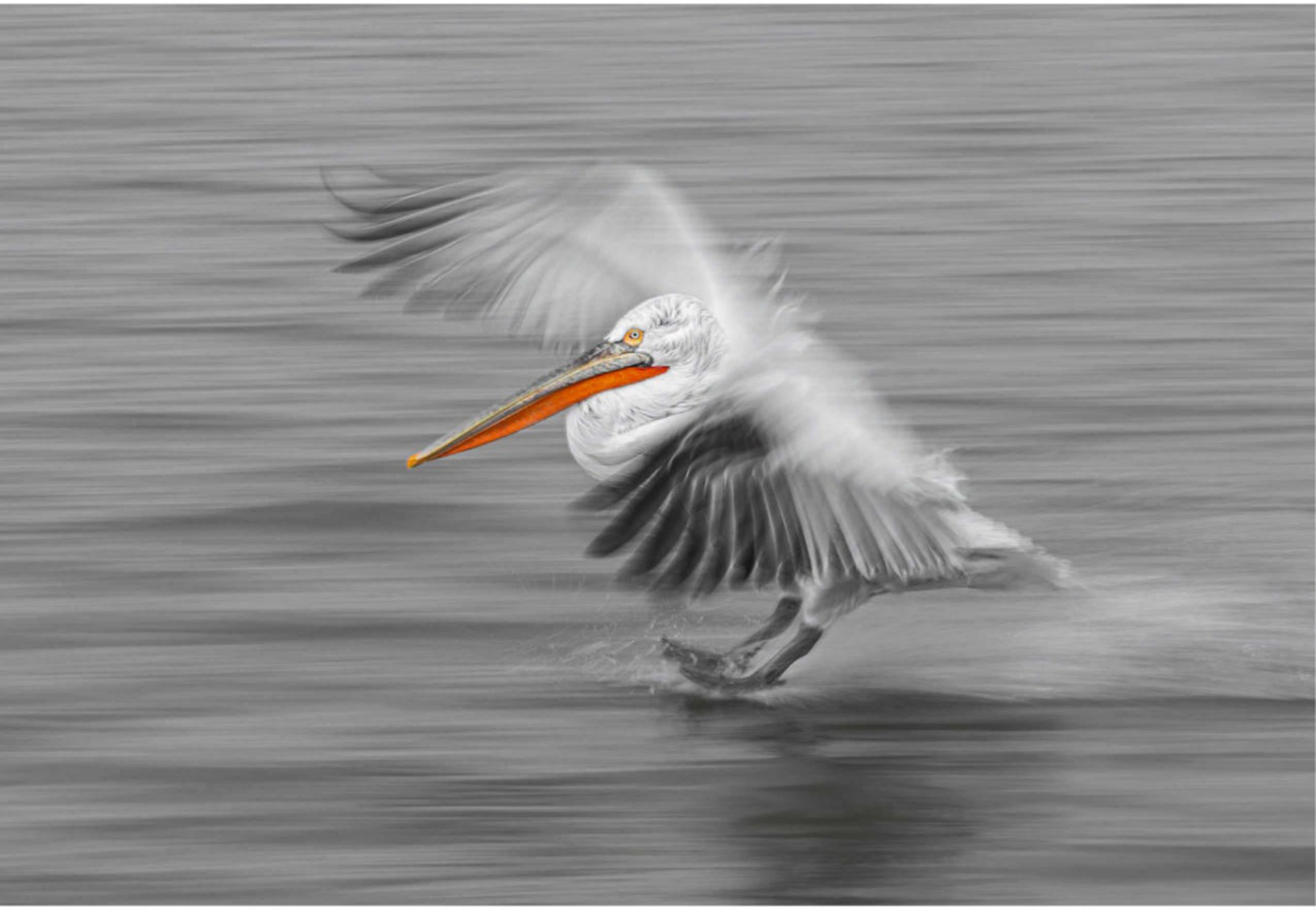


Image conscious

Spend time on the lake and you learn to tell individuals apart. "They have so much character," says Guy. "Each one has a different hairdo." Many also have distinctive markings on their throat pouches, or even small holes, caused mainly by fighting.

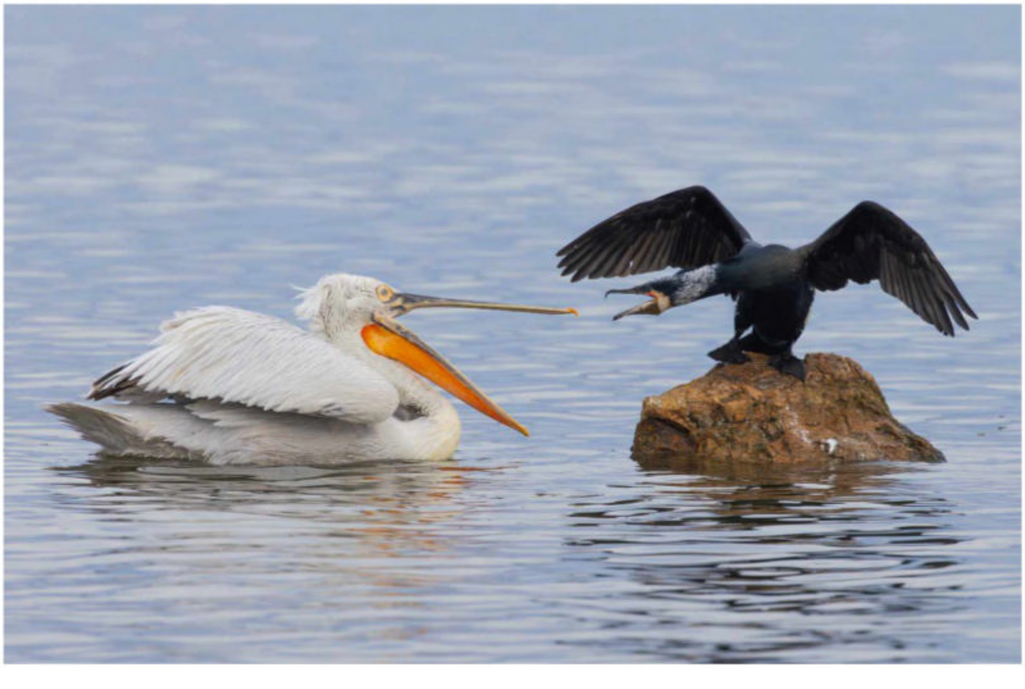


Water-skiing

With its neck braced for impact, a Dalmatian pelican lands on the lake. “They tend to ski across the surface of the water on their webbed feet to slow themselves down,” explains Guy. “Using a slow shutter speed, you have to take hundreds of pictures to get one good one. The bird’s eye must be sharp, so the panning technique has to be right.”

Precious stones

Rocks are in demand as perches to dry out and preen. “This great cormorant tried hard to defend its rock from the pelican,” says Guy. “It didn’t succeed, but even afterwards it came back and tried to push the pelican off.” The pelicans share the lake with many other bird species, including greater flamingos, great-crested grebes and even the occasional white-tailed eagle.

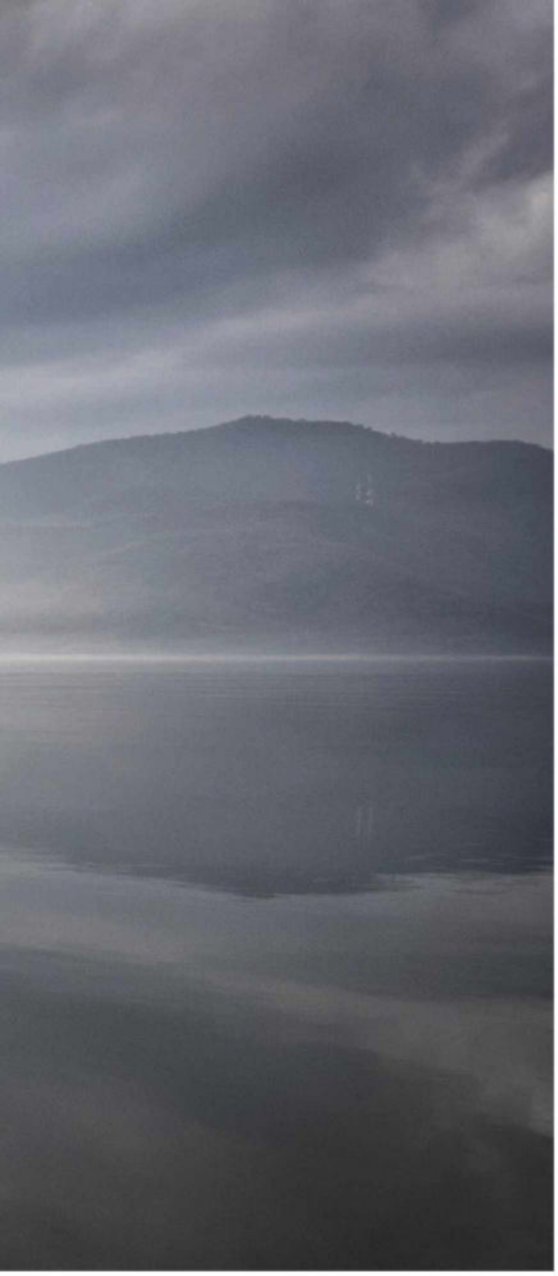


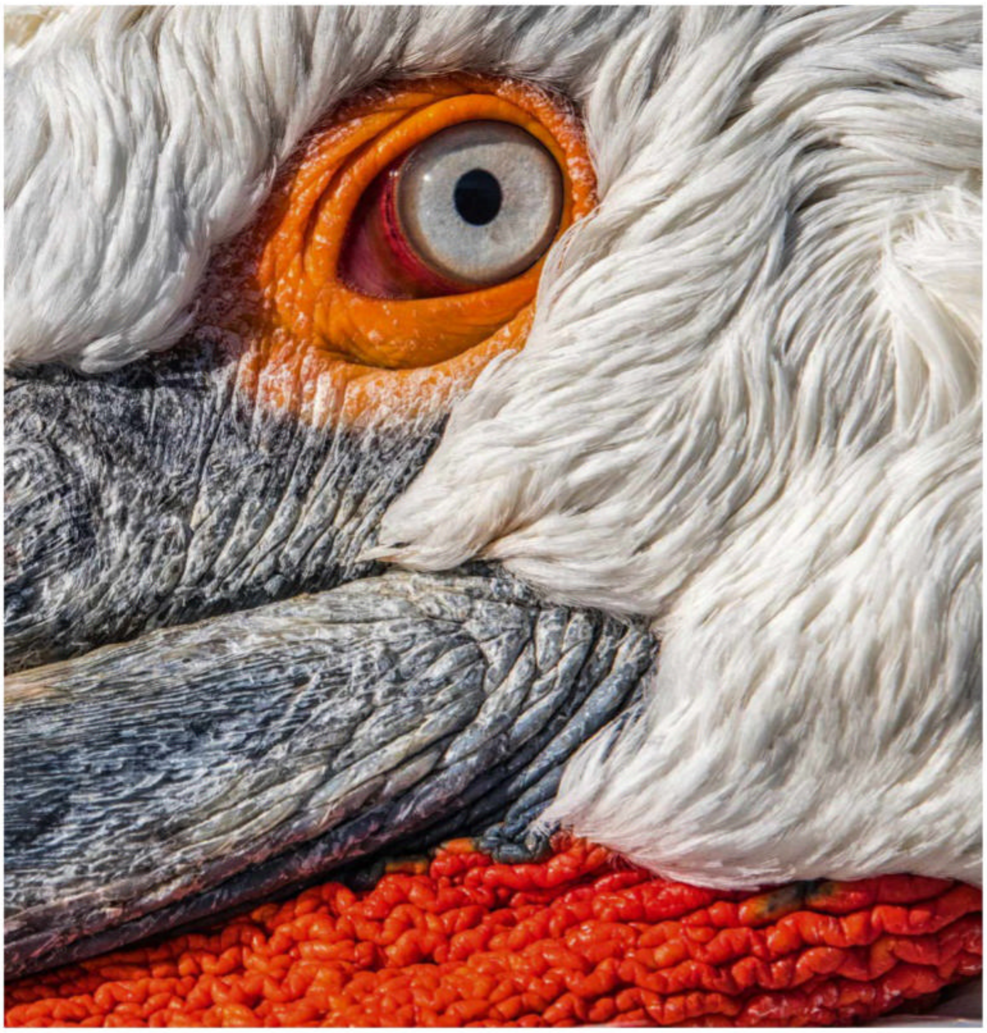
Struggle for survival

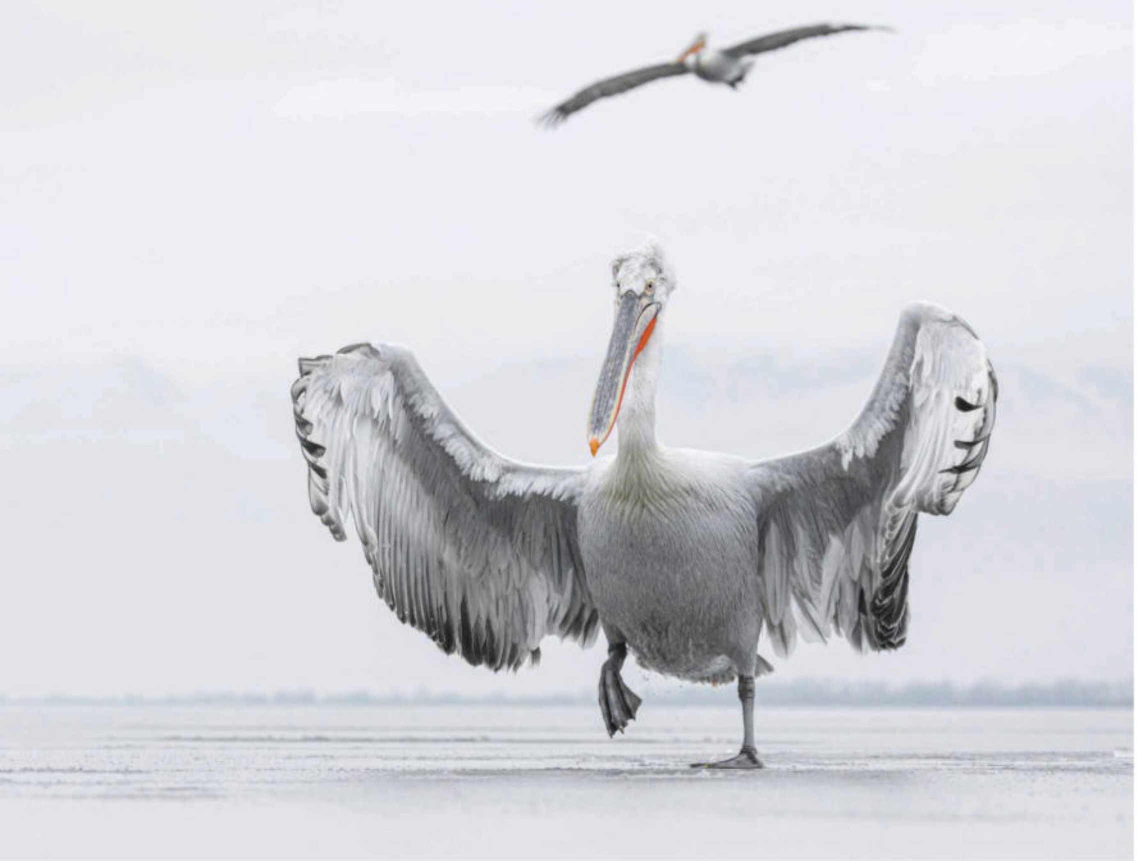
Globally the species is in decline, at around 12,000 adults, due to the combined impacts of habitat loss, avian flu and climate change. Numbers have rallied in parts of Europe in recent years, though, partly thanks to conservation efforts, especially the construction of breeding platforms at Lake Kerkini and elsewhere, including the Danube Delta, one of the species' other European breeding grounds.

Rich waters

The pelicans typically catch between 1kg and 2kg of fish a day, mainly carp. "I've never seen anywhere with so many fish," says Guy. Even so, fish numbers have fluctuated in recent years, with some locals giving up fishing because of reduced catches.





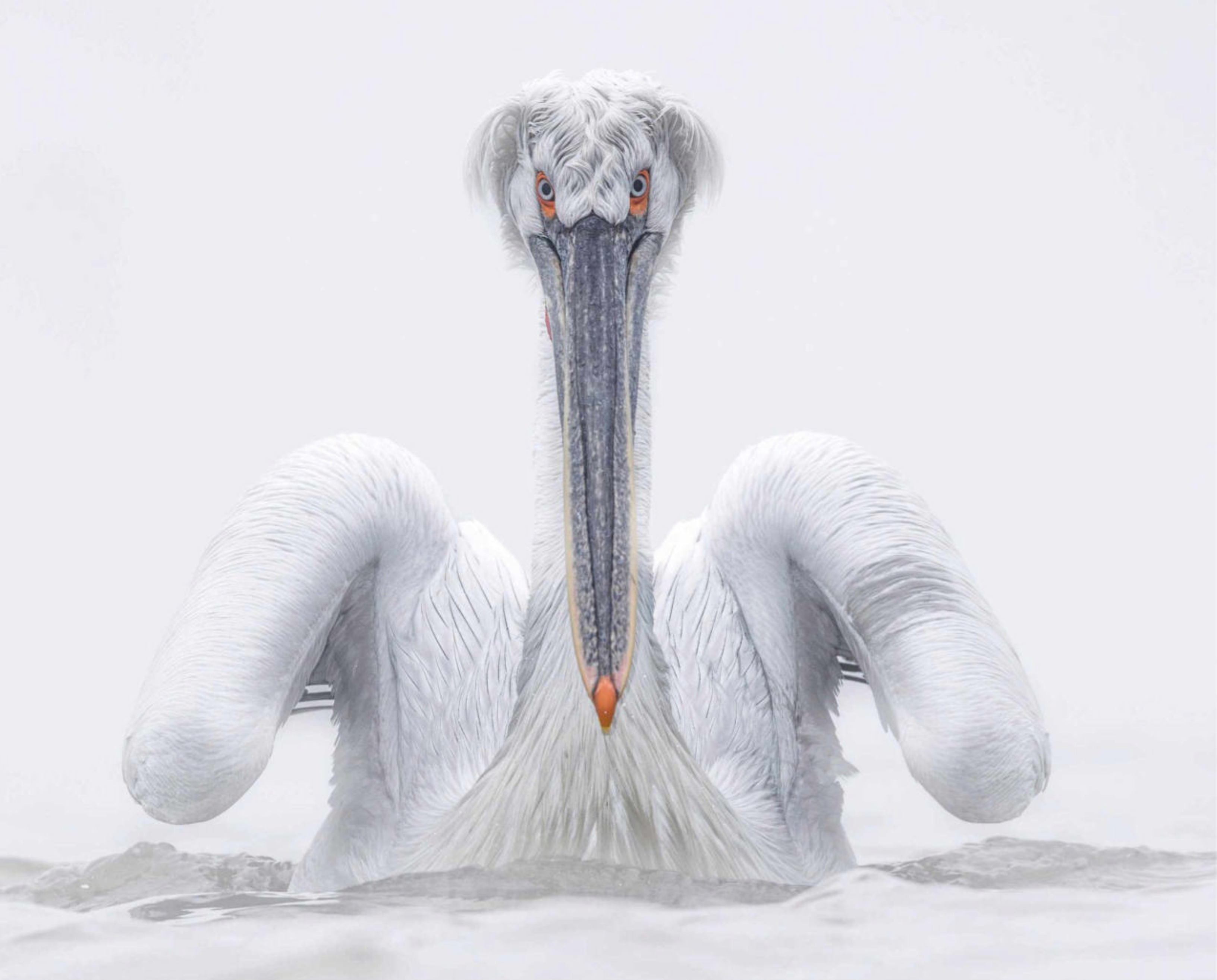


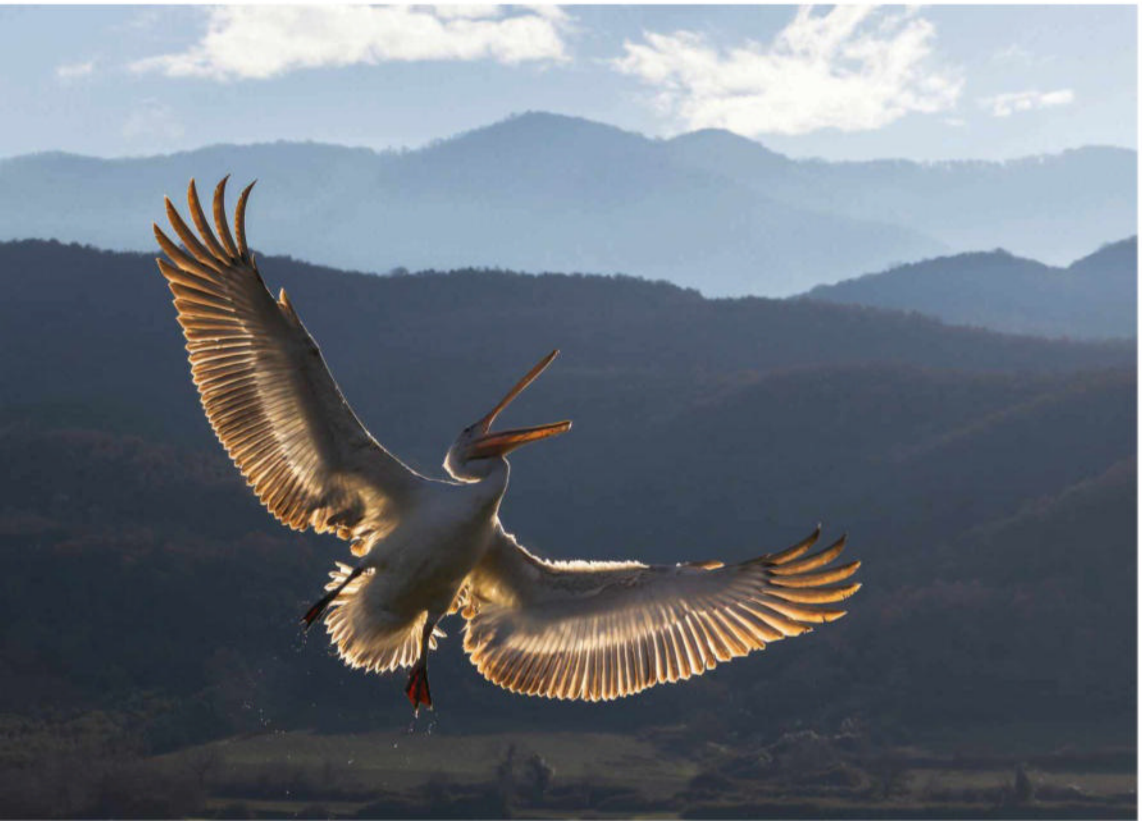
It's in the eyes

It can be hard to age Dalmatian pelicans, but the pale iris indicates that this is a mature bird. "This pelican actually landed on the boat – just a foot away from me," says Guy. "We often have to back away from the birds when they do that, because you don't want a beak in the eye."

Chill bill

Cold winds sometimes blow down from the Kerkini Mountains, which rise 2,000m above the lake, but the whole lake rarely freezes solid – as it did in 2018, for the first time in 15 years.





You lookin' at me?

"This is the classic pose of the Dalmatian pelican," says Guy. "The more dominant adults hold their wings out in this position, to make themselves look a bit larger and intimidate some of the younger birds." Guy's shot was taken flat to the ground, on the shore of the lake: "It's good to be below eye-level so the pelican is looking slightly down at you – it looks more menacing."

Heavy lifting

Unsurprisingly, the Dalmatian pelican needs huge wings to get airborne, hence its wingspan of between 2.9m and 3.45m, which is one of the biggest in the world.

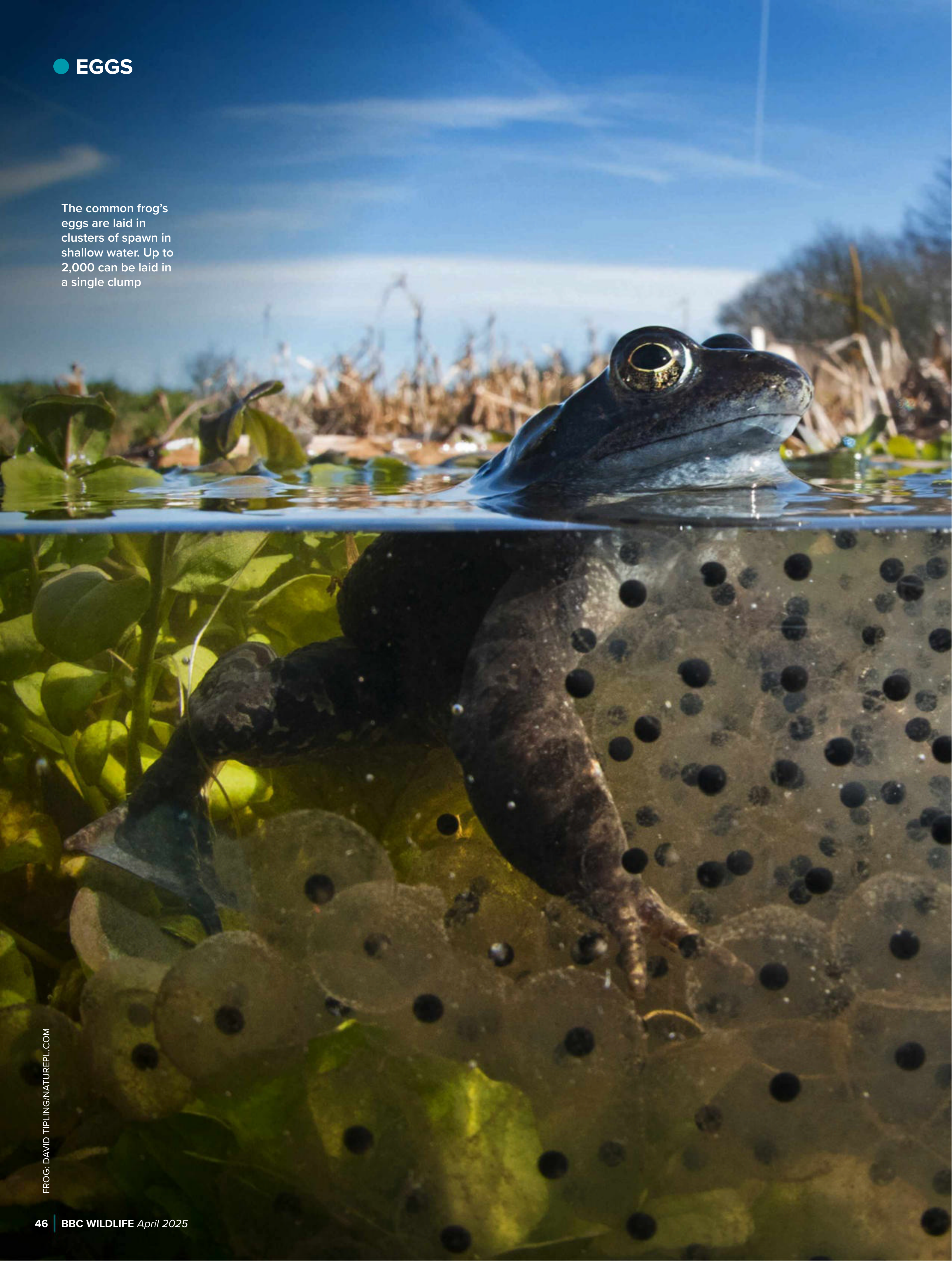
Breakfast queue

In the dawn skies, skeins of cormorants return from roosts in the surrounding forests to feed on the lake, while a squadron of hungry Dalmatians waits for the fishers to leave their moorings. Guy notes that pelicans are unusually quiet birds – making little sound except for the occasional hostile hiss when competing for fish.

Well groomed

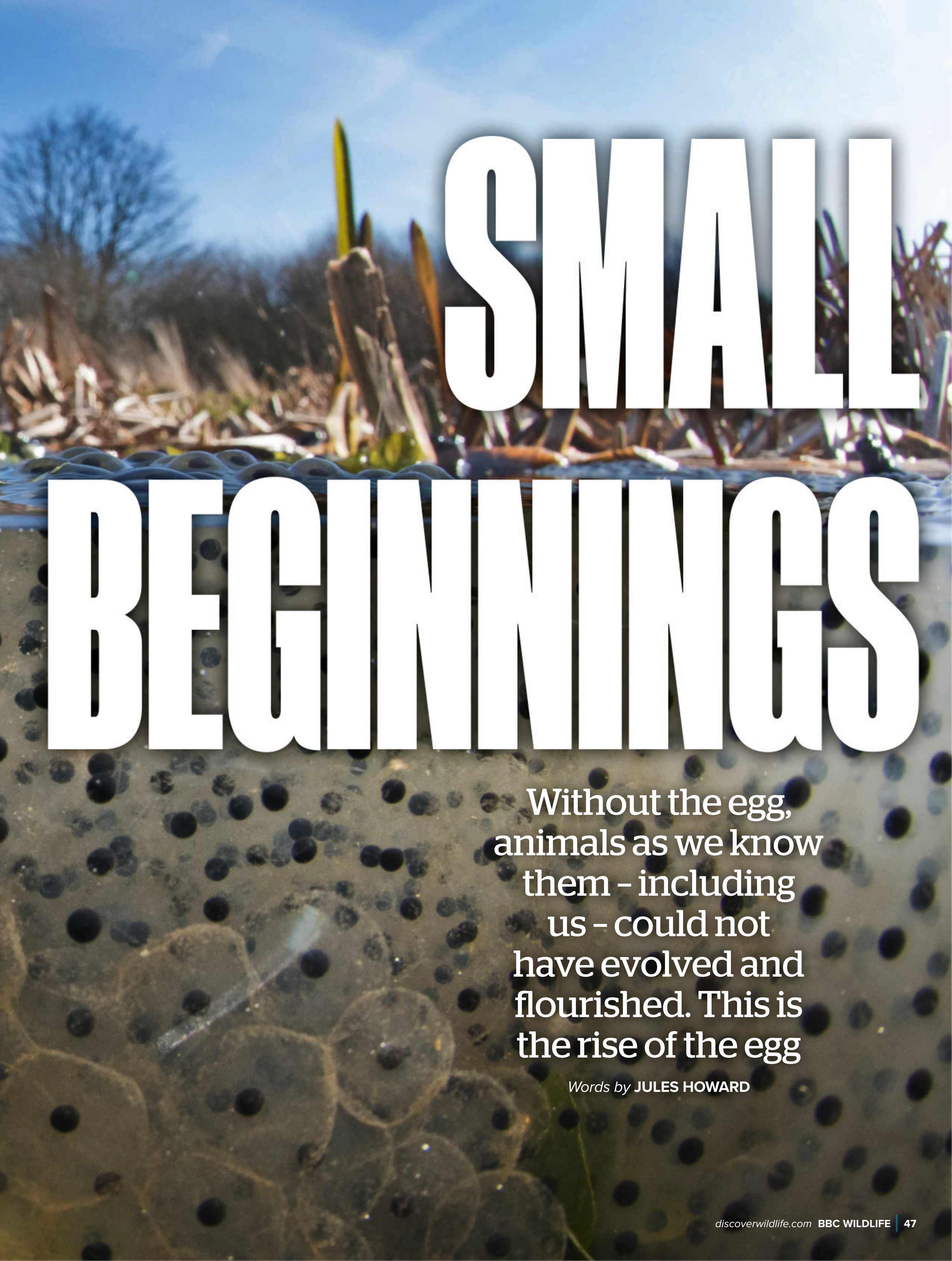
All that preening pays dividends with this beautifully kept plumage. As Guy explains, "The structure of the feathers shows up particularly well in overcast light, when there is not so much contrast between light and shade – you see all the detail."

EGGS



The common frog's eggs are laid in clusters of spawn in shallow water. Up to 2,000 can be laid in a single clump

FROG: DAVID TIPLING/NATUREPL.COM



SMALL BEGINNINGS

Without the egg, animals as we know them – including us – could not have evolved and flourished. This is the rise of the egg

Words by **JULES HOWARD**

BENEATH A WINKING fluorescent light in the corner of my childhood classroom was a fish tank within which floated something incredibly weird. It was a blob. A gooey, slimy mass, just below the surface. If you told me that aliens had snuck in overnight and put it there, I would have believed you.

It wasn't aliens, of course – it was frogspawn. And it marked the start of my first egg obsession. In the weeks that followed, the tiny life forms that generated within the slime commanded almost all of my attention. The blob was like a fortress. Hungry snails and flatworms would cruise along its surface, as if testing for weak spots, while the embryos, merely dots of dividing cells, slept their dreamless sleep.

In a matter of days, the embryos would appear to wake. Almost overnight, they became long and thin. Complex, somehow. Tails would twitch. Some would slowly spin in their spheres. In a week or so, tiny tadpoles

ABOUT THE AUTHOR

Jules is a broadcaster, zoological correspondent and science writer. His latest book, *Infinite Life: An Epic New Story of Life on Earth* (Elliott & Thompson, £10.99) is released in paperback on 8th May.

JAWFISH: DAVID FLEETHAM/NATUREPL.COM; CORAL: JUERGEN FREUND/NATUREPL.COM; BLACKBIRD EGGS: DOLORES GIRALDEZ ALONSO/ALAMY

The eyes can clearly be seen in these eggs of the mouth-brooding gold-specs jawfish

Blackbirds usually have two to three broods, each with three to five eggs

Gametes of egg and sperm bundles are released by spawning staghorn coral

> "Every egg has its own allure and an evolutionary back story as diverse as the animal that hatches out of it"

would begin to migrate through the jelly, collecting with their siblings in a depression on the upper surface of the frogspawn.

I remember this scene as if it was from a 1960s sci-fi film. But it wasn't. It was real life. Genuine, stirring real life. How could something so inert as a blob of slime produce hundreds of living things? Now, almost 40 years later, I still marvel at this question, even though I have come to understand in far greater detail the ways of the animal egg – one of the most diverse and arresting life-structures on our planet.

Every egg on Earth has its own charisma and allure, and an evolutionary back story as diverse and interesting as the animal that hatches out of it. And in many species, they are incredibly beautiful. Take the parchment-like eggs known as mermaid's purses, within which young shark and ray embryos develop; the pearly hued eggs of corals, released in shimmering clouds on moonlit nights; the eggs of stick insects, which resemble ornate wooden vases; or the eggs of the yellowhammer, imbibed with constellations of scribbles. These creations are, in every way, as memorable as those of the common frog. Each is its own vessel, whose job is to send genes forwards in time. Each egg is key to life on this planet sustaining itself.

So when did it all begin? When did eggs first evolve on Earth? The answer (to get this

Cat shark eggs, seen here on red gorgonian, are known as mermaid's purses

> "The evolutionary success of early reptiles was due to an adaptable egg with numerous membranous layers"

one out of the way nice and early) is a long time before there were chickens.

Fossils of the earliest eggs are found in rocks of China's Doushantuo Formation, dating from more than 600m years ago. These eggs come from a very early period of animal history, when most ocean creatures were little more than transparent, balloon-like animals. Many scientists think these eggs may have been laid by primordial jellyfish. Remarkably, within some of these incredible fossil specimens are cells apparently in the process of division – some eggs have two cells within them, some have four, eight, 16 and so on. These were some of the earliest eggs – the forerunners of what was to come.

In time, in their billions, eggs would be flushed across the oceans and eventually be brought to land. Millipedes, which deposited their pearl-like eggs in moist muds, were among the first egg-layers. Land scorpions and primitive mites were next. Some began retaining eggs in the body, safe from cold nights and fiery daytime temperatures, a strategy retained by scorpions to this day.

About 380m years ago, natural selection saw land-fish evolve legs from fins. In time, the unthinking forces of natural selection chiselled reptiles from these early land-fish, finessing more and more, with each passing period, a new egg for the land.

The key to the evolutionary success of early reptiles was a very adaptable egg. Within it were numerous membranous layers, each with its own role. Some of these (such as the 'allantois') helped the embryo to breathe and remove its waste. Another, the yolk sac, provided food for growth. These early reptile eggs (known as 'amniote' eggs) were wrapped in a breathable armour (the 'chorion'), later given an external coating of calcium carbonate by some dinosaurs and, later, by birds.

Modern-day birds' eggs have become, to some, the most proficient and perfect life-structures of all. Carefully deposited in nests in trees and on cliffs, and strong enough to endure storms, avian eggs are jaw-droppingly diverse.

The blackbird's look almost as though they have been carved in glossy jade. The guillemot's are covered in what look like artistic sketches, natural illustrations printed on to the eggs' crystalline shells as they pass through the bird's oviduct (egg tube). The rock bunting's eggs have a Jackson Pollock quality to them, while the mockingbird's are adorned with splodges that resemble tea stains. From the impressionist simplicity of the dunlin's eggs to the cloud-like markings

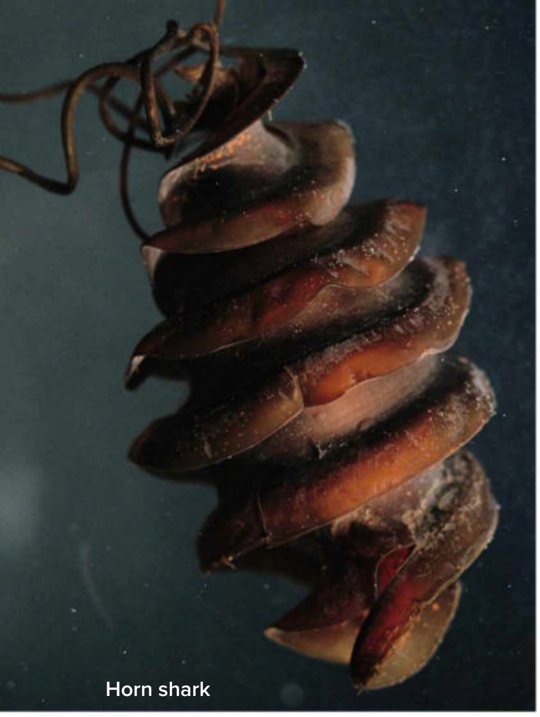
Devising eggsit strategies

Mammals aren't the only animal group to have hit upon 'live birth' as an egg-laying strategy. In the vertebrates alone, live birth has evolved separately at least 140 times. The behaviour is very common in reptiles, particularly snakes, including the adder, whose babies are born cased in a transparent sac from which they must quickly free themselves.

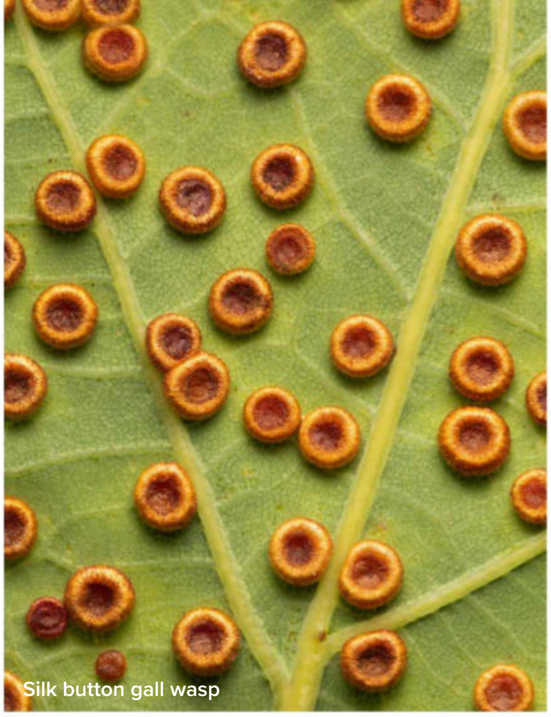
Some reptile species are more fluid in their reproductive strategies. The Australian three-toed skink is able to give birth to offspring in cooler conditions, such as on cold mountains, and lay eggs in warmer conditions at lower altitudes. In one observation, a single skink produced eggs and live babies in a single litter.

Young adders must quickly escape the membrane that they're born in

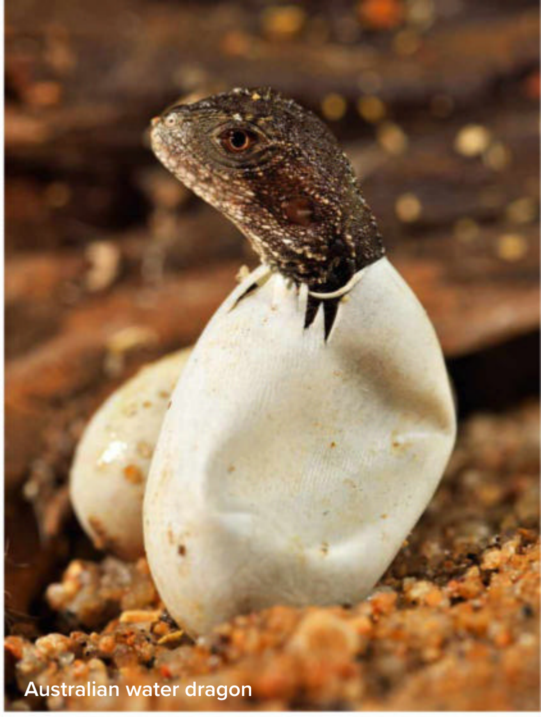
CAT SHARK EGGS: FRANCO BANFI/NATUREPL.COM; ADDER: TONY PHELPS/NATUREPL.COM; HORN SHARK: NORBERT WU/NATUREPL.COM; WASP: ALEX HYDE/NATUREPL.COM; DRAGON: DANIEL HEUCLIN/NATUREPL.COM; BLENNY: SERGIO HANQUET/NATUREPL.COM; OCTOPUS: FRED BAVENDAM/NATUREPL.COM; BUTTERFLY: ANDY SANDS/NATUREPL.COM: LIMPET: TONY WU/NATUREPL.COM: SPIDER: GIL WIZEN/NATUREPL.COM: STICK INSECT: PAUL STAROSTA/NATUREPL.COM



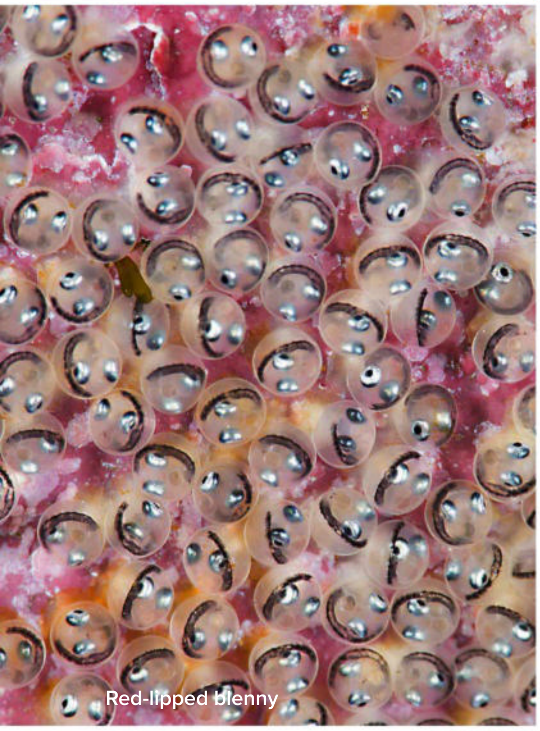
Horn shark



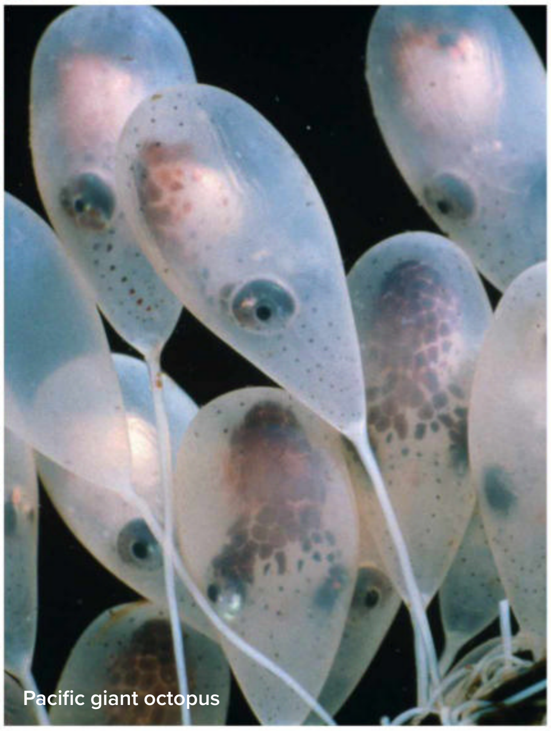
Silk button gall wasp



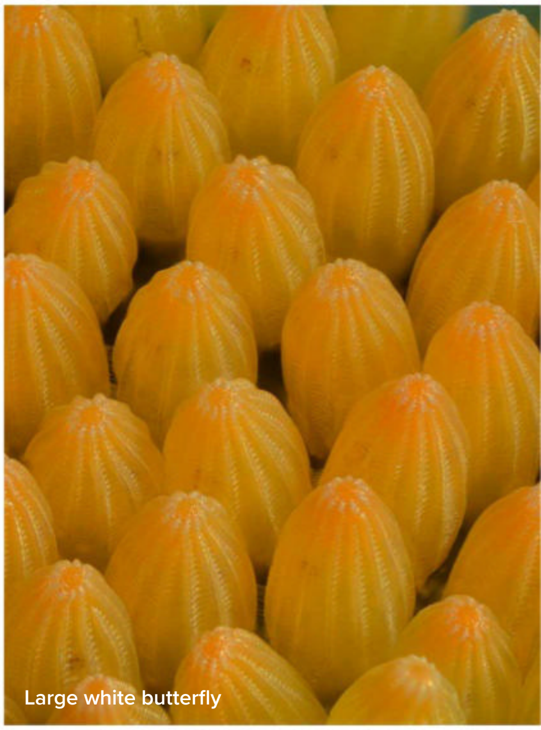
Australian water dragon



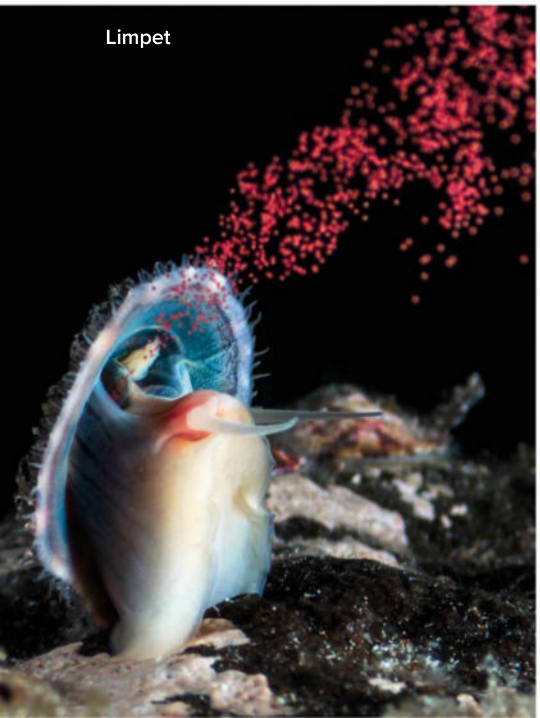
Red-lipped blenny



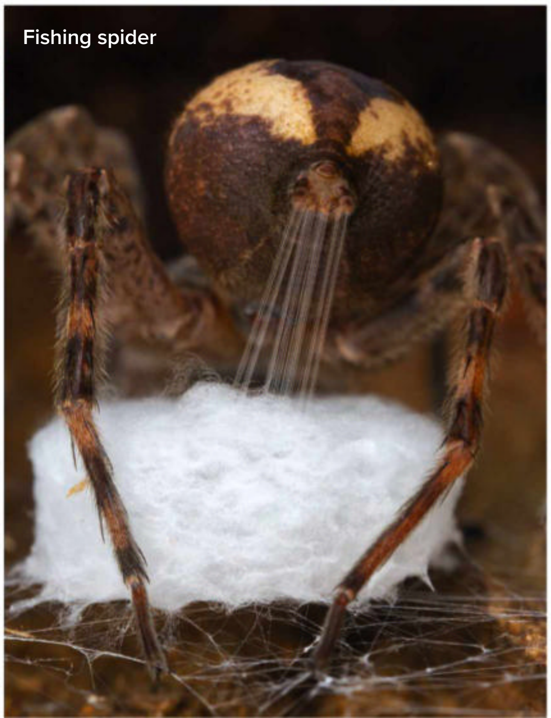
Pacific giant octopus



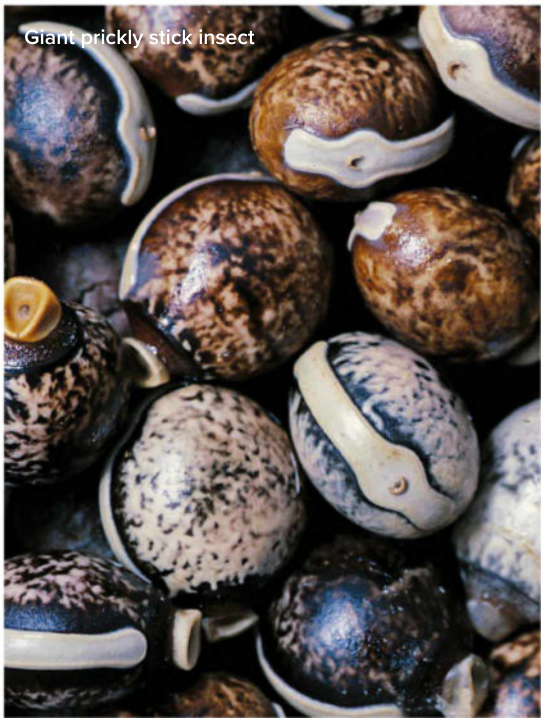
Large white butterfly



Limpet



Fishing spider



Giant prickly stick insect

Dinosaur egg fossils on display at the Heyuan Dinosaur Museum in China

Heading for eggstinction

Were eggs part of the reason why dinosaurs faced extinction, long ago? Recently, by investigating fossils of dinosaur embryos, scientists deduced that dinosaur eggs grew more slowly than the eggs of modern-day birds, taking, in some cases, many months to hatch. These scientists argue that, as the world recovered from the meteorite explosion that occurred 66 million years ago, dinosaurs may have been outcompeted by mammals and birds, who repopulated their ecosystems more quickly than their rivals, specialising into new roles as they went.

Mammals, such as this barbary macaque, took advantage of the internal egg

on those of the sandwich tern, it's clear that eggs have something to say.

Why has evolution hit upon this unthinking passion for artistic expression in birds' eggs, especially? Traditionally, the explanation was that their markings and colours were about protection from the sun (pigment might offer a form of natural sunscreen) or camouflage from egg predators. Take the eggs of little terns and ringed plovers, for instance, laid on scrapes on pebbly beaches, which perfectly blend with their surroundings.

But the truth is actually far more arresting. Many scientists now suspect these markings may be a way for parent birds to fight back against cuckoos and other nest parasites eager to trick others into rearing their offspring. The sudden appearance of an unmarked egg in a nest of decorated eggs is treated with suspicion by many bird species, and for good reason: no one likes a cheat.

Colours and markings on eggs were once considered a uniquely bird thing, but research in 2015 demonstrated that this adaptation was in fact pioneered by the dinosaurs, particularly the bipedal dinosaurs known as theropods, such as *Tyrannosaurus* and *Velociraptor*, from which birds evolved. *Velociraptor*, it turns out, laid speckled eggs, rather like those of a sparrow.

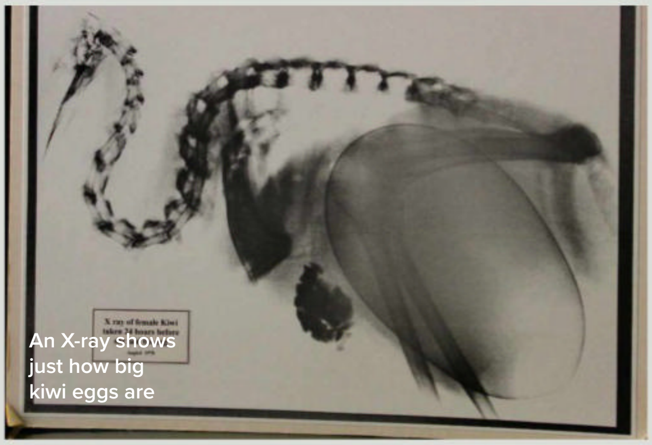
More than 200m years ago, what was once a reptile-like egg in mammals with many layers lengthened its stay in the egg tube and modified some of the membranous layers to support an internal way of life for the embryo. The allantois and yolk sac fused into an umbilical cord, connected to the mother via an intermediary, the placenta, which is essentially a blood-sucking nutrient-hoover with responsibility for feeding and cleaning the embryo.

By being kept warmer for longer inside the body, early mammals prospered in cooler environments and, probably, flourished in the colder, night-time realm – a niche unavailable to reptiles, including early dinosaurs, which were less proficient at regulating body temperature. Following the demise of the dinosaurs 66 million years ago, mammals were well-placed to take over. And so now, this is the era of the internal egg, the great age of bellybuttons. Mammals such as apes, lions, whales and bats have evolved to take centre stage in life's modern menagerie.

DINOSAUR EGGS: VCG/GETTY; MACAQUE: THOMAS MARENT/NATUREPL.COM

This male leafy seadragon is carrying eggs while swimming over a seagrass meadow

LARGE AS LIFE



An X-ray shows just how big kiwi eggs are

Going to eggstremes

At 30cm long, and weighing more than two dozen chicken eggs, the ostrich egg is the largest of all bird eggs. However, for the size of the bird, the ostrich's egg is small – it weighs between 1 and 4 per cent of the adult bird. Compared to body size, the record-holding egg-layer is the kiwi of New Zealand. A single kiwi egg takes up about 20 per cent of the female kiwi's bodyweight.

Why the difference? Often, in environments that are relatively free from predators, natural selection becomes drawn to increasing embryo size. Animals become more likely to 'bet' more on bigger babies because it usually offers a 'safe return' on their investment. Familiar animals that employ this strategy include whales, large sharks and, notably, humans. In New Zealand, an environment that, for many millions of years had no mammalian egg-predators, the kiwi was pulled toward this strategy. How quickly the kiwi and its giant egg may adapt to the presence of introduced rats, cats and other mammalian egg-predators is yet to be seen.

> "An egg is something that is inert and apparently lifeless, yet is capable of the extraordinary"

Are we mammals, with our inside egg, at the pinnacle of egg evolution now? The answer is – and there is no other way to say it – a decisive no. Because this is, by way of numbers (one million species and counting), an insect planet. We just happen, in this geological period, to share their ecological space.

As with reptiles, eggs are an important and often overlooked part of the insect success story on planet Earth. Their ecological dominance is all down to the 'serosa' – an egg adaptation like no other. Within the insect egg, the serosa acts like a protective blanket wrapped around the embryo, which reduces the amount of water vapour the egg loses to the environment while the embryo grows. This simple innovation, hit upon more than 300m years ago, allowed insect eggs to get into the strangest places and, against all odds, survive.

At some times of the year, insect eggs are everywhere. Turn over the leaf of an oak tree in spring or summer and whole ecosystems of insect eggs can be discovered. One might see the eggs of a shieldbug, arranged like bowling pins on the leaf underside. Hold the same leaf up to the light and you might see galleries made by leaf-mining caterpillars, hatched from eggs in the stem.

You might spot aphid eggs, black as tiny ticks on the twigs, or the miniature nursery grounds of tiny wasps, known as galls, within which grubs hatch from eggs deposited by the long stinger of the adult wasp. Repulsive to some gardeners? Perhaps. Radical, innovative and evolutionarily trailblazing? Undoubtedly. For me, through insects especially, the egg obsession continues.

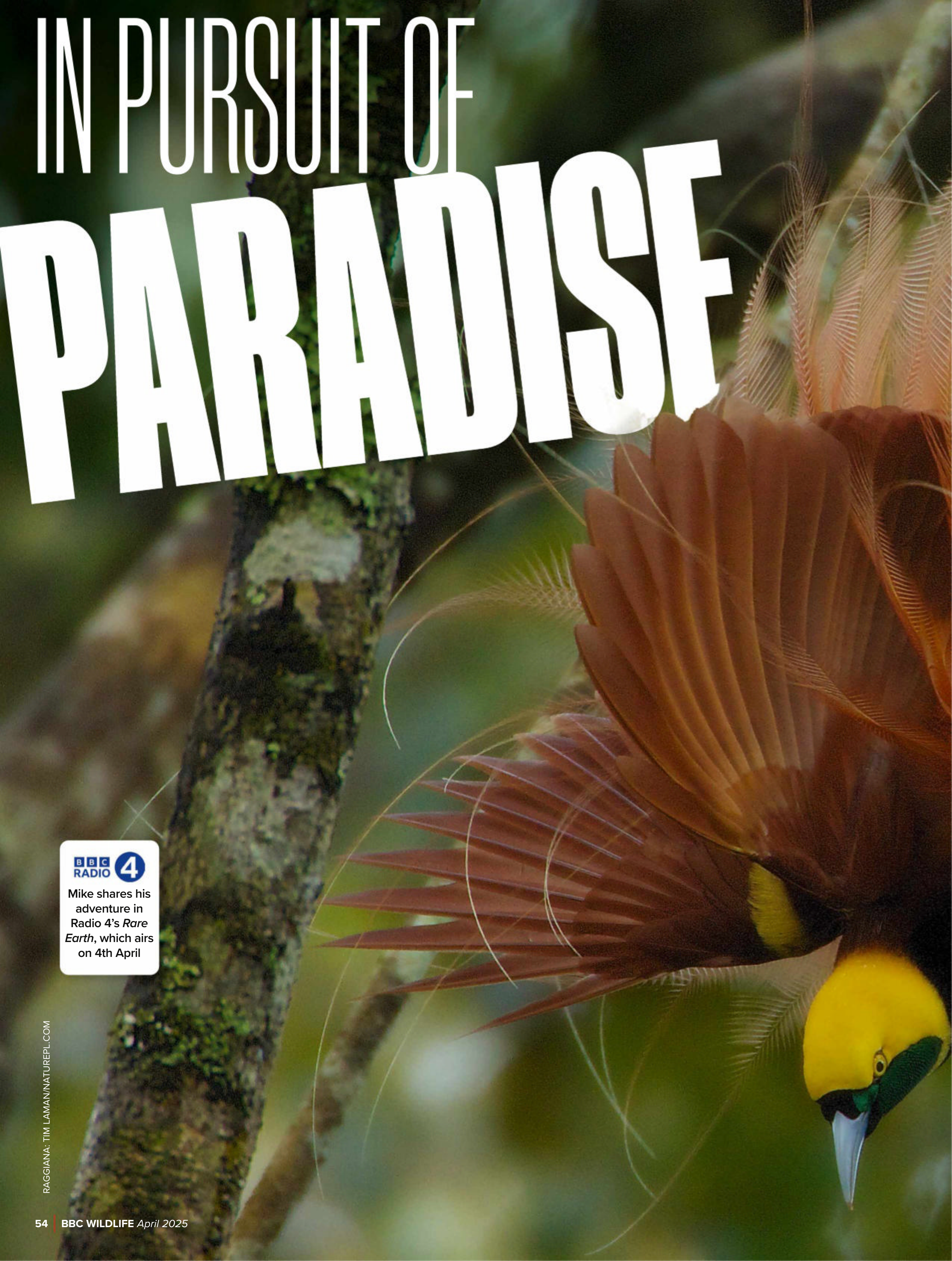
Rock bunting eggs have a highly distinctive pattern

Researching new scientific findings – of insect eggs, amphibian eggs, the mammalian placenta, the crystalline shelled eggs of birds – has changed my perspective on animals. I have become so invested in eggs that I now see animals not as individuals but merely vehicles that natural selection has produced to make more eggs.

In a funny way, it really is true. An egg is something that is inert and apparently lifeless, yet is capable of the extraordinary. And so, for each of the images on these pages, I am the child in the classroom again, squinting through the tank to admire the frogspawn, fogging up the glass, imagining where this enduring life structure may take us next. Onwards, through life. Into the infinite.

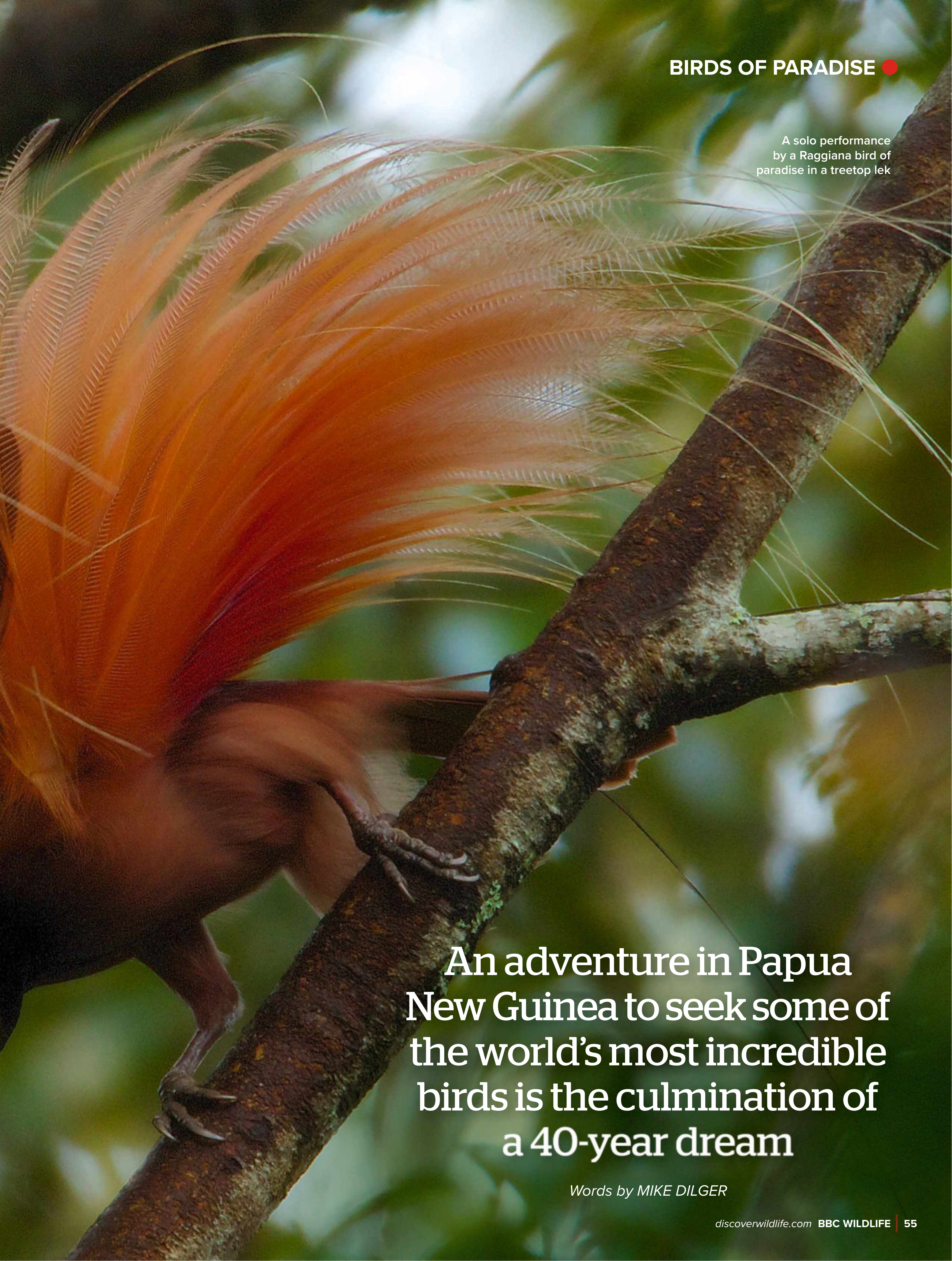
SEADRAGON: ALEX MUSTARD/NATUREPL.COM; X-RAY: NATALIA LASHMANOVA/ALAMY; ROCK BUNTING EGGS: KLEIN & HUBERT/NATUREPL.COM

IN PURSUIT OF PARADISE



Mike shares his adventure in Radio 4's *Rare Earth*, which airs on 4th April

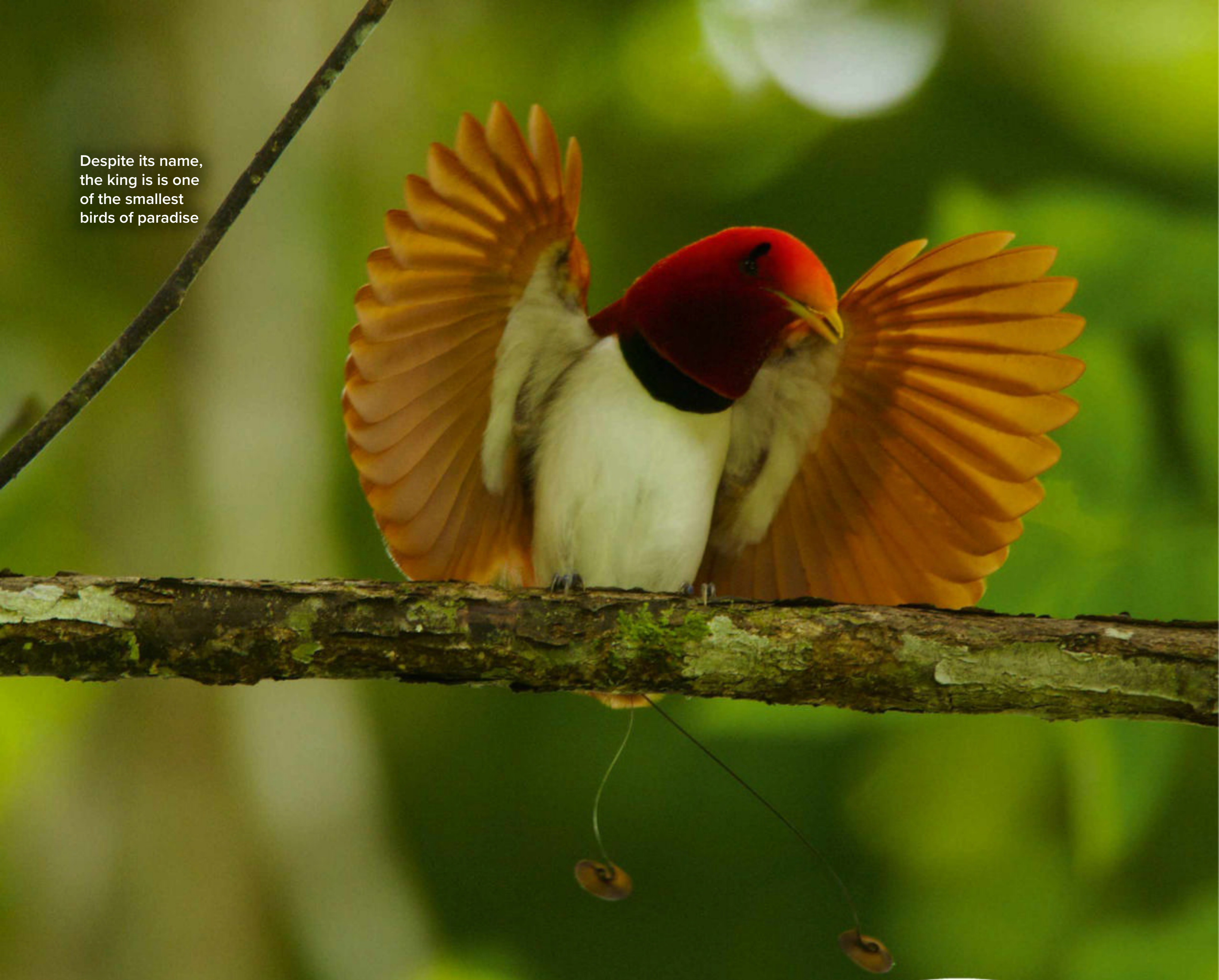
RAGGIANA: TIM LAMAN/NATUREPL.COM



A solo performance by a Raggiana bird of paradise in a treetop lek

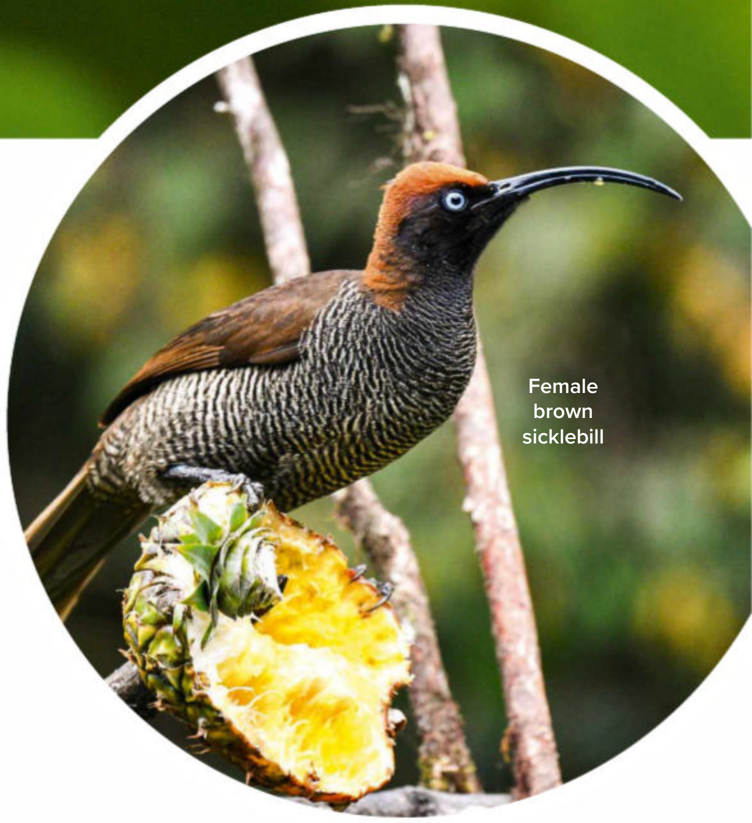
An adventure in Papua New Guinea to seek some of the world's most incredible birds is the culmination of a 40-year dream

Words by MIKE DILGER



Despite its name, the king is is one of the smallest birds of paradise

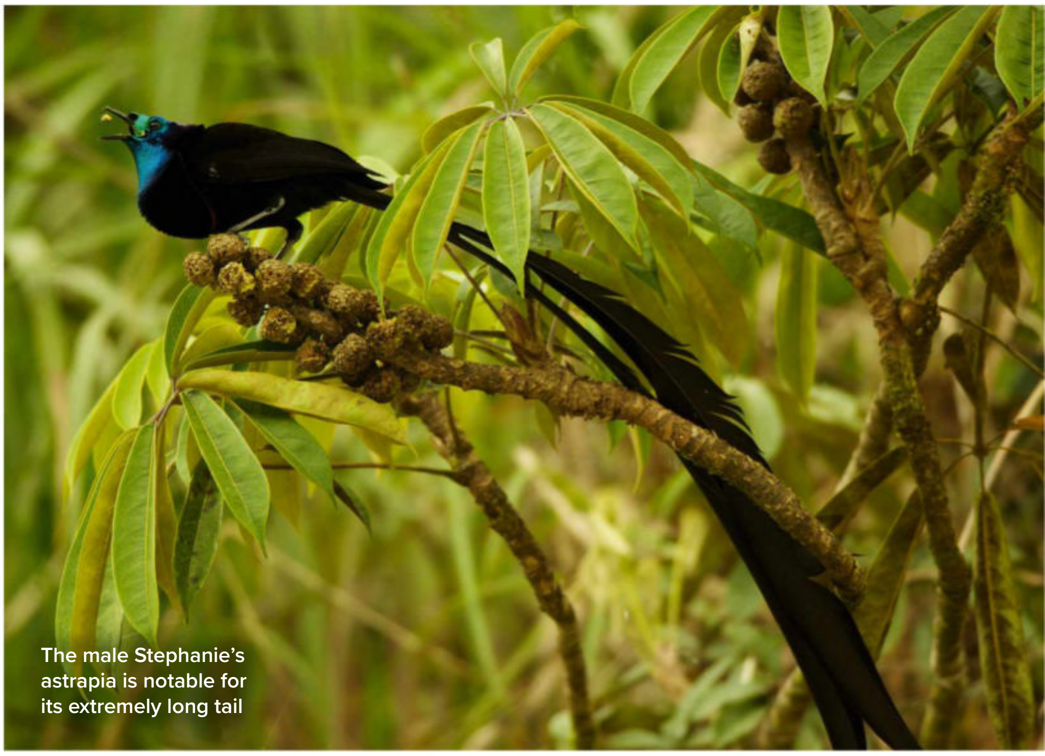
IF THERE WAS EVER proof that good things come to those that wait, it was my recent and unforgettable visit to the renowned birding destination of Papua New Guinea.



Female brown sicklebill

KING BIRD OF PARADISE: TIM LAMAN/NATUREPL.COM; SICKLEBILL: LAURENS STEIJN

The view towards Mount Hagen, where Mike's trip was based



The male Stephanie's astrapia is notable for its extremely long tail

Reading Alfred Russel Wallace's *The Malay Archipelago* as a teenage birder, I recall being transported to a land of astonishing birds with unparalleled beauty and wonderfully bizarre ornamentation. More inspiration came with Bruce Beehler's *Birds of New Guinea*, the first definitive field guide to the island. Flicking through page after page of sumptuous illustrations, it was always the birds of paradise that flew straight off the pages and into my imagination.

I knew I would see them for myself one day but I never imagined that day would take almost four decades to come: it was October 2024 when I finally touched down on the world's second-largest island.

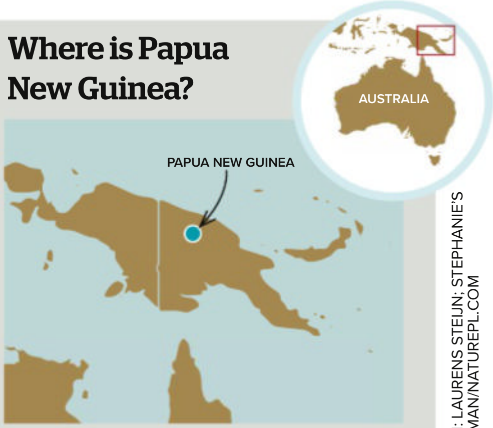
Papua New Guinea is synonymous with birds of paradise, hosting 33 of the world's 45 species. Some 26 also reside in Indonesia's autonomous province of West Papua, with a handful in North Queensland and the remote islands of the Malay Archipelago. But actually finding them, particularly in Papua New Guinea, is widely touted as the 'toughest birding you'll ever do'.

It's not hard to see why. Two-thirds of Papua New Guinea is still forested, with a whopping 85 per cent classified as 'untouched'. Many birding locations are remote and difficult to access, and permission to enter tribal lands is not easy to come by.

ABOUT THE AUTHOR

Mike is a naturalist, author and tour guide, and is also the wildlife reporter for BBC's *The One Show*.

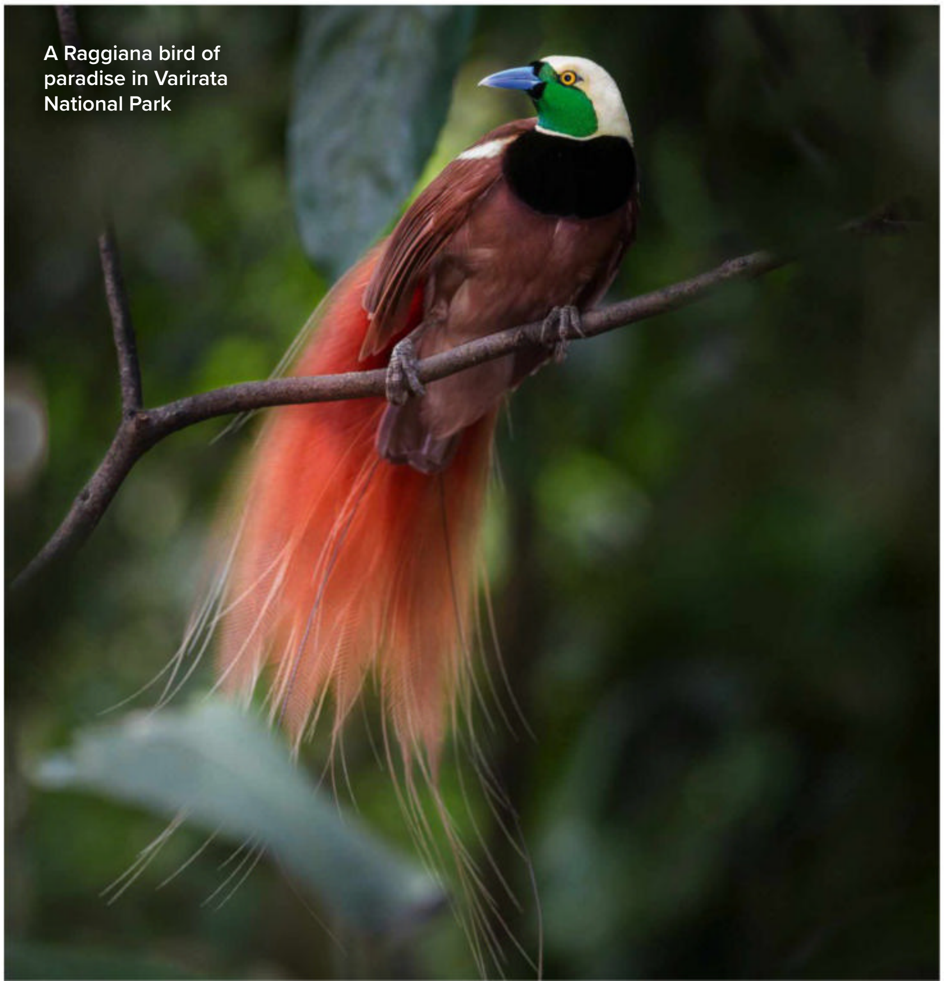
Where is Papua New Guinea?



Papua New Guinea is in the south-western Pacific Ocean. It is the eastern half of the island of New Guinea (the western half comprises provinces of Indonesia).

MAGIC MOUNTAIN: LAURENS STEIJN; STEPHANIE'S ASTRAPIA: TIM LAMAN/NATUREPL.COM

The dense, mist-soaked forests of the Wahgi Valley



A Raggiana bird of paradise in Varirata National Park

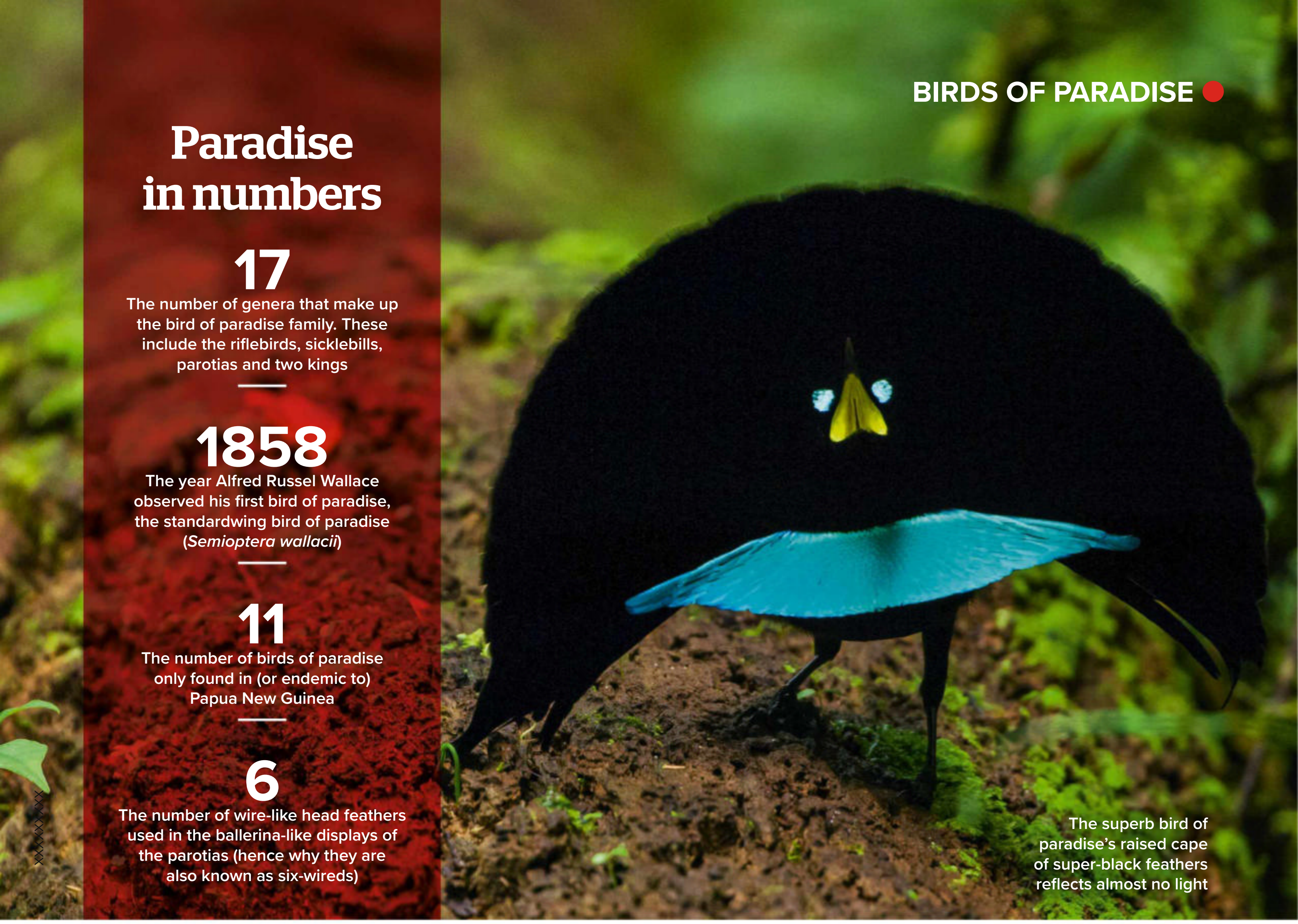
MOUNT HAGEN: HEMIS/ALAMY; KING OF SAXONY: TIM LAMAN/NATUREPL.COM; RAGGIANA: NICK GARBUTT/NATUREPL.COM

Even if you do manage to get there, you have to negotiate steep, rugged terrain and cope with the challenges of dense tropical forest. And finally, with intense hunting pressure in certain locations, these birds have become highly elusive.

But seeing these forest jewels can still be done, as I was to find out. I'd been invited to Papua New Guinea as part of a group to learn about the eastern side of the island, and would be based in the central Highlands, around Mount Hagen. This extinct volcano lies in the sweeping, fertile Wahgi Valley, hemmed in by tree-covered ridges that have barely changed in tens of thousands of years.

A SHORT DRIVE INTO THE HILLS took us to our first birding spot of Kumul, a lodge tucked into Mount Hagen's forested flanks. Its owners put out supplementary fruit, much like we do with peanuts and sunflower hearts.

"Be prepared for something special," teased our guide, Wilson, as we walked through the dimly lit corridors into a space that doubled as both dining room and bird hide. Peering through the slats on the end wall, I could see a stage comprising a series of fruit-laden bird tables connected by



The superb bird of paradise's raised cape of super-black feathers reflects almost no light

Paradise in numbers

17

The number of genera that make up the bird of paradise family. These include the riflebirds, sicklebills, parotias and two kings

1858

The year Alfred Russel Wallace observed his first bird of paradise, the standardwing bird of paradise (*Semioptera wallacii*)

11

The number of birds of paradise only found in (or endemic to) Papua New Guinea

6

The number of wire-like head feathers used in the ballerina-like displays of the parotias (hence why they are also known as six-wireds)

horizontal wooden bridges. I didn't need a field guide to identify the male brown sicklebill tucking into papaya to my right, and the male Stephanie's astrapia expertly extracting pineapple pulp to my left.

Just like that, having mentally prepared for blood, sweat and tears, I had bagged my first birds of paradise. My first impression was just how large they are – almost a metre in length from crown to tail tip. My second, with the sun beating down, was the dazzling iridescence of their plumage.

Famed for its unique courtship display, the brown sicklebill – along with its close relative, the black sicklebill – is endowed with feathery, epaulette-like tufts that it raises over and behind its head into a scimitar-shaped crescent. While the astrapia is not quite as capable of such levels of transmogrification, it more than compensates with a pair of preposterously long and brilliant-white tail feathers, and a scintillating green sheen that would have even South America's hummingbirds reaching for their sunglasses.

Also hopping among the feeders was a female brown sicklebill, who was decidedly less glamorous than her male counterpart. The reason, of course, the males look and act like they do is down to these powerfully fussy females. Over countless generations, the females' preferences have driven the males to favour beauty over utility. In other words, how you look and display trumps other important survival strategies, such as mastery of flight or the ability to hide from predators.

Added to that, New Guinea has a complex geological history that has forced birds of paradise to endure successive periods of isolation over the past 20m years. This physical isolation, even over relatively small areas across the island, combined with intense sexual selection, has led to the stunning diversity present today.

I had an instant craving for more. I was rewarded the next day at another lodge called Magic Mountain, whose slightly lower elevation in the cloudforest provided an entirely different suite of species. Another feeding station instantly delivered the spectacular ribbon-tailed astrapia, which is subtly different to the Stephanie's. Handsome though it was, the ribbon-tailed was no more than a warm-up act to surely one of the island's most sought-after species: the King of Saxony.

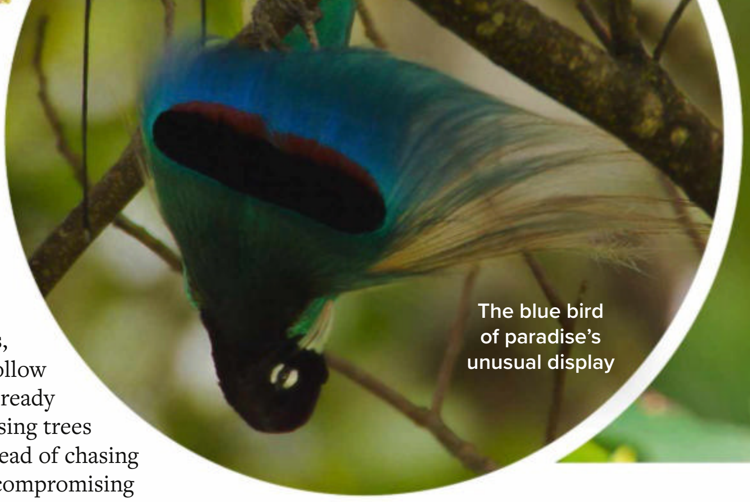
> "Over countless generations, the females' preferences have driven the males to favour beauty over utility"

THE SECRET TO FINDING THE trickier birds of paradise, such as the celebrated King of Sax, is not to head randomly into the nearest patch of forest but to be targeted in your approach. Employing an experienced guide who knows the location of display perches is crucial. And so it was that our new guide, Paul, whisked us away to a prominent line of trees at the forest edge.

SUPERB BIRD OF PARADISE: TIM LAMAN/NATUREPL.COM

“It’s quite surreal coming face-to-feathers with a bird you’ve waited half a lifetime to see, and the ‘King of Sax’ did not disappoint”

Feeding stations at Magic Mountain are used to attract birds



The blue bird of paradise's unusual display

Slathered in lotion to keep both the sun and the mosquitoes at bay, we desperately scanned the canopy for movement. As is so often the case with birding, we heard our quarry before we saw it. Sounding like a cross between a hyperactive cicada and bad radio static, the peculiar call enabled us to pinpoint a male high on a branch.

NO LARGER THAN A EUROPEAN starling, his black back, head and bib contrasted with his yellow belly and orange wing bar. But his dapper hues were eclipsed by his outlandishly lengthy head-plumes, which resembled the antennae of a long-horned beetle and were being wafted around in extravagant fashion.

It's quite surreal coming face-to-feathers with a bird you've waited half a lifetime to see, and the King of Sax did not disappoint, flying straight into the top five of the 3,000 or so species of bird I've been lucky enough to see. But with the clock ticking, there could be no dawdling. We moved on to our next high-altitude destination, taking the short but bumpy road across to the other side of the Wahgi Valley.

Rondon Ridge has long been celebrated as one of the best locations for birds of paradise in Papua New Guinea. It was only 50km from the forests we'd just visited but its physical separation resulted in yet another new assemblage of species. We met our guide, Joseph, at dawn. He explained that, as many birds of paradise are dedicated frugivores, the smart move is to "follow the fruit". Joseph had already pinpointed some promising trees and suggested that, instead of chasing ghosts in the tough, uncompromising forest, we let the ghosts come to us.

When it comes to searching for birds in tropical forest, patience is essential. An hour quietly watching and waiting produced nothing more than a grand total of two sightings – the yellow-browed melidectes and the endemic Papuan white-eye. Both were 'lifers' to virtually everyone in the group, yet were not the reason we had travelled all this way.

Rondon Ridge sits at an altitude of more than 2,000m, and the chilly morning air had caught us out. Shivering and fidgeting, we were about to call it quits but Joseph implored us to persevere. As if by way of reward, a vision in blue suddenly flashed past and took up a prominent position in a tree, clearly ready for breakfast.

The male blue bird of paradise is not only one of the world's most beautiful birds but also one of the easiest to identify, thanks to a combination of electric-blue wings and tail, amber flank plumes and long black tail streamers, all set against glossy black upperparts. His astonishing display involves hanging upside-down then spreading out and shimmering his flank plumes while tossing his head from side to side like a manic metronome.

> "His astonishing display involves hanging upside-down and tossing his head from side to side"

WHILE OUR LUCK DIDN'T extend to the display, we were nevertheless thrilled with our front-row seat as this bobby-dazzler of a bird gulped down a few berries before melting back into the forest. Then, to our utter joy, the same tree played host to a male greater lophorina. Perhaps better known by its former name of superb bird

FEEDING STATIONS: LAURENS STEIJN; BLUE BIRD OF PARADISE: TIM LAMAN/NATUREPL.COM

Male blue bird of paradise in the Southern Highlands

of paradise, this species' scarcely believable display was first filmed in 2006 for the BBC series *Planet Earth*.

The bird has since been split into three species, the males of which can all raise not only their startling blue breast shields but also an array of jet-black nape plumes, fanning them out into something resembling an extended version of Dracula's collar. This striking costume is topped off with small patches of iridescent blue feathers above the eyes, giving the impression of a slightly demonic but mesmeric grinning face.

Males usually select a horizontal log as a dance floor but witnessing their display usually requires weeks in a tiny, cramped forest hide. Nonetheless, we were treated to the first act with the arrival of a brown and streaky female, who prompted the male to momentarily raise the feathers of his breast shield, forming what superficially looked like a huge and lustrous moustache.

The days were passing quickly. We had had more hits than misses (we won't mention the unsuccessful two-hour wait for a noisy king bird of paradise to show himself). Yet one mega-bird remained on our list. Celebrated as Papua New Guinea's national bird, the Raggiana bird of paradise is supposedly named after an obscure 19th-century Italian marquis called Francesco Raggi. Every inch the quintessential bird of paradise, the males have outrageous orange-red flank plumes and iridescent green throats.

THE PENULTIMATE DAY OF the trip took us to Varirata National Park, which sits on the appropriately named Bird's Tail Peninsula. It's by far the most popular reserve in the country and was the first time I'd felt on the beaten path. It was here that I hoped for a rendezvous with the Raggiana.

This is a lekking species. Several males turn up at dawn and dusk to display at a long-established arena high in the canopy. The ritual has been fine-tuned over millennia with the sole purpose of impressing any fastidious females looking to couple up.

Arriving at sunrise and barely a few steps from the access road, all we had to do was step into the forest and gaze into the noisiest section of canopy above our heads, where the lek was apparently in full swing. Two competing males fluffed up their candy-floss flank plumes, lowered their opalescent heads and frantically flapped their wings to reassert their position in the pecking order. This ostentatious behaviour was accompanied by otherworldly calls.

The Raggiana marked my 10th and final bird of paradise in just a week. For a moment, standing among the trees, I was that teenage birder again, this time witnessing these wondrous birds for real. I wondered what must have crossed Wallace's mind when he first laid eyes on this startling display back in the 1850s – it must have blown his socks off, too. Was it worth the 40-year wait? Absolutely.

BLUE BIRD OF PARADISE: TIM LAMAN/NATUREPL.COM

TO CATCH A CAIMAN

Words and photos by **LOUIS GUILLOT**

A young dwarf caiman (*Paleosuchus trigonatus*) at night in a rainforest stream

Studying caimans in the Amazon can help the species' conservation – but you have to catch one first

GLIDING DOWN THE TAMBOPATA River in the Peruvian Amazon, I understand the luxury of being on a boat at night in the jungle. The air is thick with 35°C heat and 99 per cent humidity. The constant breeze generated by our moving vessel offers much-needed respite from the sweltering conditions, while also keeping the relentless mosquitoes at bay.

Chris Ketola, head field research coordinator for conservation NGO Fauna Forever, is standing at the bow. Using a powerful torch, he is searching for caimans lurking in the dark waters. Caimans are mostly nocturnal, which is why we are out at night. Three species inhabit this region: the white, black and dwarf caiman (*Caiman crocodilus*, *Melanosuchus niger* and *Paleosuchus trigonatus*).

I am part of a crew of five and we are here to record any caiman we see and, where possible, catch them to gather crucial data such as body measurements. This will help us to learn more about caiman biology and assess population health, which will aid in the species' conservation.

After 20 minutes, a large shape drifting in the river's strong current comes into view. We quickly realise it's a huge tree, likely uprooted in a storm the previous night, and we are on a collision course with it. Instincts kick in and both Pipi, the boat driver, and Chris spring into action. Pipi, sitting at the back of the boat and unable to see ahead, depends entirely on Chris for prompts and accurate directions.

Meanwhile, Chris uses his torch to deliver a series of complex light signals that help Pipi with navigation. With calm

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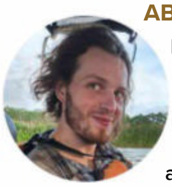
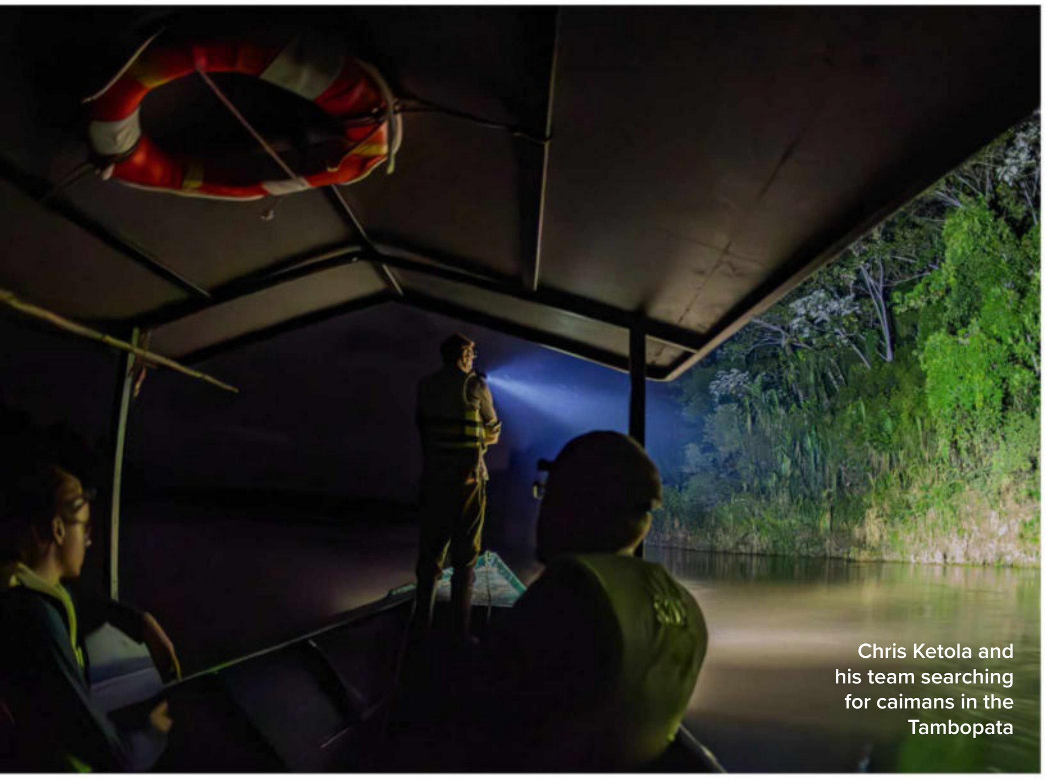
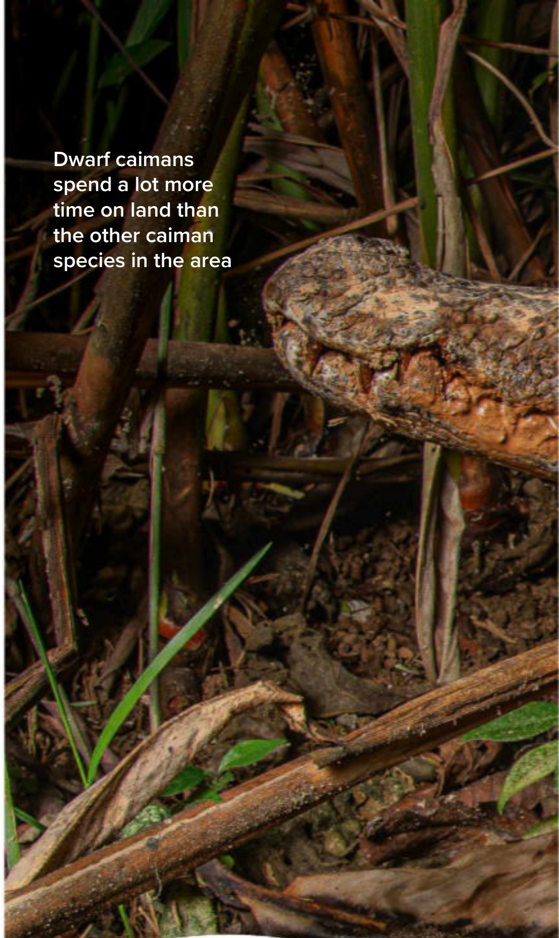
ABOUT THE AUTHOR



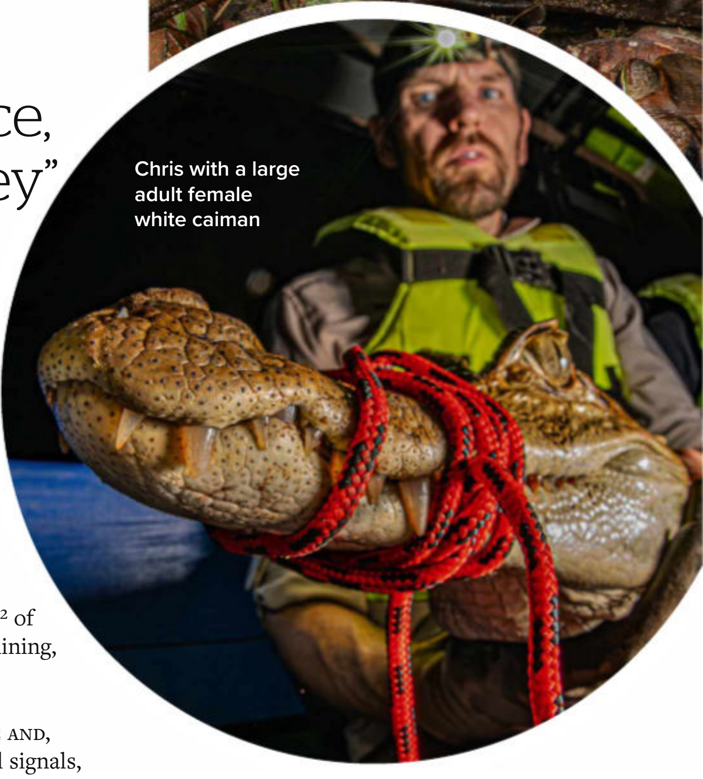
Louis Guillot is a wildlife photographer and conservationist. He lived in the Amazon rainforest for eight months. Find out more at instagram.com/louis_guillot.



Chris Ketola and his team searching for caimans in the Tambopata



Dwarf caimans spend a lot more time on land than the other caiman species in the area



Chris with a large adult female white caiman

> “Only their eyes and nostrils emerge from the water’s surface, rendering them invisible to prey”

precision, Pipi narrowly dodges the log. I let out a sigh of relief but everyone acts as if the near miss was simply part of the night’s routine. Moments later, the reflective eyes of a caiman catch in Chris’s torchlight – two glowing orange lights close together, just above the water’s surface. We alter our course, approaching slowly and quietly.

I first fell in love with the Amazon after a trip to Tambopata in 2017 and dreamed of immersing myself in this environment for an extended period to document its beauty. As the most biodiverse terrestrial environment in the world, with trees as far as the eye can see, the Amazon offers the perpetual thrill of discovery – you can find things here that few or no others have seen. The prospect of coming across a jaguar, or a beautiful snake or frog, or even an entirely new species, gives me an unparalleled rush of excitement.

It was in November 2023 that this dream became a reality. I embarked on an eight-month trip to Tambopata in the Peruvian Amazon, starting my work with Fauna Forever. The organisation was founded in the 1990s by conservation biologist Chris Kirkby to help protect wild spaces worldwide, particularly in the Amazon. The team engages the local community in conservation efforts and conducts field research activities, such as caiman monitoring, camera-trap projects and bird surveys.

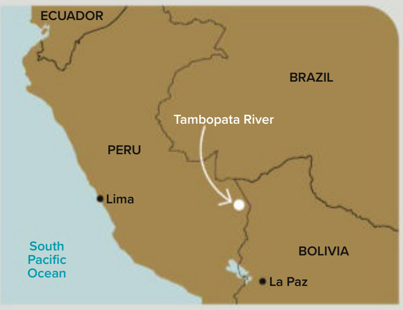
Their efforts illustrate how biological monitoring can drive conservation efforts, contributing to the establishment of the Tambopata National Reserve in September 2000. This achievement safeguarded 2,750km^2 of forest from threats such as gold mining, deforestation and cattle ranching.

Pipi cuts the engine and, using Chris’s careful signals, glides the boat alongside a caiman, stopping about an arm’s length away. As we slow to a halt, buzzing mosquitoes swarm around us for a quick meal. With utmost concentration, Chris crouches into a catching position.

He slowly extends his hand above the reptile, pauses then – splash! He plunges his hand into the water, aiming for the caiman’s neck. Securing his hold on the animal, he pulls it out. “A juvenile white caiman,” he states, “about a year old”. Its pale colour helps with identification.

This is my first close-up look at a wild caiman and I’m in awe: its eyes, tiny crystalline white teeth and armoured skin are beautiful and detailed. I’ve long been fascinated by caimans and all crocodilians. These animals reached evolutionary perfection millions of years ago and their unchanged shape since the time of dinosaurs reflects this.

Where is the Tambopata River?



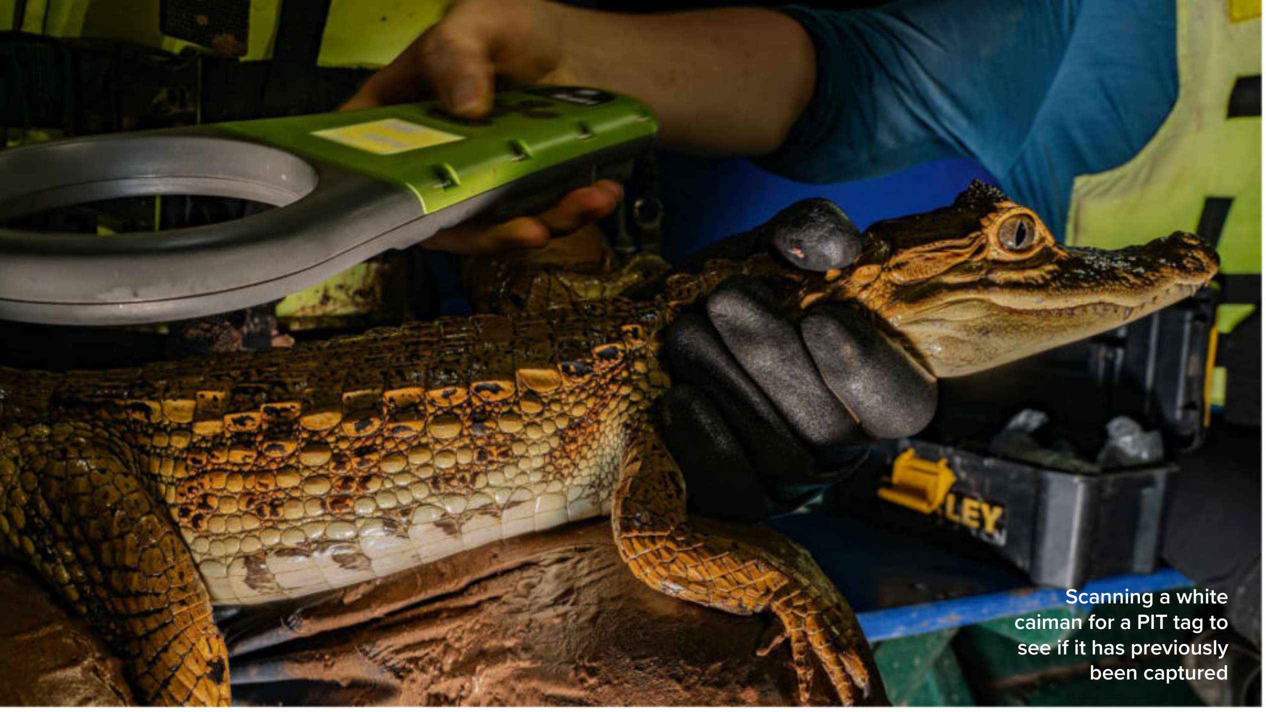
The Tambopata River begins in the Puno region of the Andes and flows into the Madre de Dios River near Puerto Maldonado in Peru. Stretching roughly 400km, its length shifts from year to year as its winding course continuously reshapes due to the natural erosion of its banks.

Perfectly adapted to their semi-aquatic lifestyle, only their eyes and nostrils emerge ever so slightly from the water's surface, rendering them invisible to prey. Their streamlined bodies and powerful tails make them excellent swimmers, and their pressure receptors can detect prey such as fish in the murkiest of waters and on the darkest of nights. One particularly amazing adaptation is their palatal valve, which allows them to swallow prey underwater without choking.

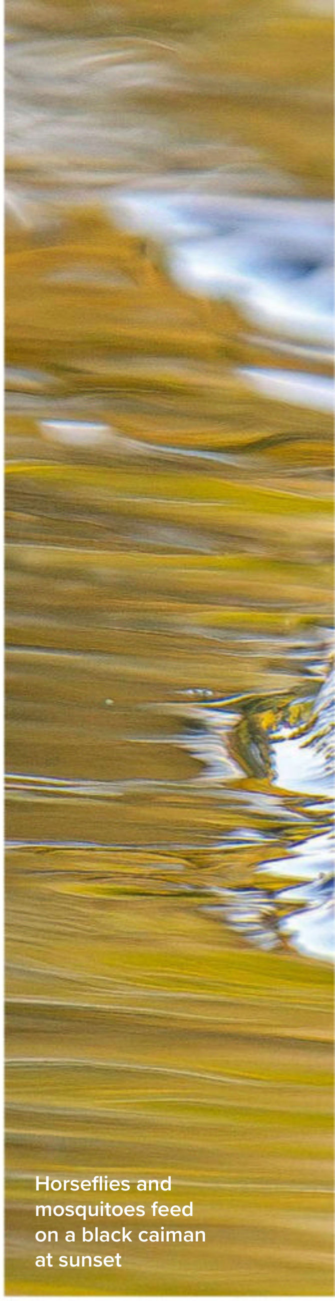
CAIMANS ARE TRUE SURVIVORS. I've seen black caimans missing half their tails but still thriving. Most crocodilians are opportunists and eat a variety of prey, such as fish, insects, crustaceans, birds, snakes and larger mammals. They may have a sinister reputation, yet crocodilians are incredibly caring, arguably the best reptile parents. On a previous field trip, I'd spotted a 1.2m-long white caiman in a jungle stream. A loud hiss warned me she had babies and I gladly backed away, knowing she'd defend them despite being smaller than me. Crocodilians embody both power and tenderness. They have thrived for millions of years and I hope will continue to do so for many more.

As we delve deeper into the night, more caimans are caught, including a large 1.7m-long adult. The final individual, a youngster of about 70cm, presents our biggest challenge. We approach but, just as Chris goes for the catch, the caiman vanishes, resurfacing among reeds. Moving closer might scare it off, so Chris decides to jump out of the boat. With a tally of nearly 300 caimans caught to date and thousands more monitored by sight, he has the experience and skill to make this call.

I wait, my heart racing. Chris sinks into reeds, shallow water and thick mud, and



Scanning a white caiman for a PIT tag to see if it has previously been captured



Horseflies and mosquitoes feed on a black caiman at sunset

TAMBOPATA RIVER

Threats to biodiversity

The Tambopata River nourishes the vibrant ecosystems of south-east Peru. Normally crystal clear, its waters turn murky only after floods or when riverbeds are disturbed by miners in search of gold. Though a section of the river is protected by the Tambopata National Reserve, illegal mining has surged here, particularly during the Covid-19 pandemic.

Mercury, used to separate out alluvial gold, has detrimental impacts on both human health and biodiversity as it spreads through the food chain. The surrounding forests are among the most biodiverse on Earth, home to 7 per cent of the world's bird species, 4 per cent of all mammals, and more than 1,200 butterfly species.

Iconic wildlife such as jaguars, harpy eagles, giant anacondas and macaws still thrive in these forests, but their survival is increasingly imperilled by human encroachment and the toxic impacts of gold mining.

A red and green macaw eating sodium-rich clay

The boat the Fauna Forever team use on the Tambopata River in search for caimans

makes a swift movement. "Got it," he shouts. He turns and I see a figure covered in mud with a caiman in one hand. "I'll be showering fully clothed tonight," laughs Chris.

Curious as to how it feels to catch a caiman, I ask what goes through his mind. "I'd imagine it's like hunting," he says. "It fulfils the same primordial instinct humans have to test themselves against animals. Except there's a scientific purpose."

ONCE A CAIMAN is caught, the researchers gather data as quickly as possible to minimise stress to the animal. First, the species and its sex are identified. Then its health is assessed, and measurements such as body length and tail circumference recorded. The whole operation takes about 10-15 minutes in total.

Prior to release, each caiman is tagged with a microchip known as a passive integrated transponder (PIT). Data from repeated captures provides insights into growth rates, age and territoriality. Boasting one of the largest global databases of caiman recaptures, Fauna Forever has learned a great deal about caiman biology. "Better knowing a species biology allows for more informed conservation planning and choices," says Chris.

One behavioural trait the organisation has learned is the high site fidelity of white caimans, who are often recaptured in the same area. This information could support future research into mercury contamination, a toxic by-product of gold mining in the Madre de Dios watershed. If caimans consistently inhabit the same area, analysing mercury bioaccumulation through nail samples could clarify the geographical distribution of this pollutant and the impact it is having on the caiman population. And since caimans are a common food source for Amazonian communities, assessing mercury levels is vital for evaluating the potential health risks from their consumption.

“Chris has had his fair share of injuries. His wrist was once gripped by a caiman and ‘death-rolled’ three times”

In the 1960s and 70s, the black caiman was in serious decline due to hunting for its skin. Populations are recovering well and the other two species aren’t currently at risk. However, long-term monitoring remains vital, as even abundant species can decline alarmingly quickly. The common passenger pigeon went extinct rapidly in the early 20th century. Had its population been properly monitored, the decline might have been noticed in time to act.

CATCHING CAIMANS IS NOT EASY and comes with obvious risks. I ask Chris about his thin neoprene gloves, which don’t appear to offer the slightest protection against sharp crocodilian teeth. “A caiman will bite right through these,” he says. “I wear them as they give me grip, so I don’t drop one and risk injuring us both.”

Chris has had his fair share of caiman-inflicted injuries. On one occasion, his wrist was gripped firmly by a caiman and ‘death-rolled’ three times, leaving a substantial scar. Some black caimans reach 5m in length and could inflict serious damage. But fatal encounters are rare, usually occurring when people swim at night – something to avoid in the Amazon.

Compared to their Australian and African cousins, the saltwater and Nile crocodiles, black caimans are less aggressive and do not actively hunt humans. Common sense is essential in crocodilian fieldwork though. When Chris once wrestled a 2.9m, 100kg black caiman, he had the support of four others to safely manoeuvre his quarry on to the bank. The most significant danger when monitoring caimans is the Tambopata itself, with its strong currents, whirlpools and changing tides. Chris experienced this first-hand when he was once swept off the boat and pulled beneath the surface. Had he not been wearing a lifejacket, he likely would have drowned.

We have spent four hours on the water, and Chris has caught eight caimans, all of which have been monitored. Our work is done for the night, so we head back upriver to camp. Later on, safely cocooned under my mosquito net, I’m resolute in the belief that we can’t give up on the fragile Amazon. Fauna Forever’s work – and the dedication of individuals such as Chris – offers hope for this very special ecosystem. Now, more than ever, we must persevere.

GIRAFFE WITH VISITORS: AVPICS/ALAMY

A visitor feeds a giraffe at Colchester Zoo, which offers a 'group giraffe feed' experience

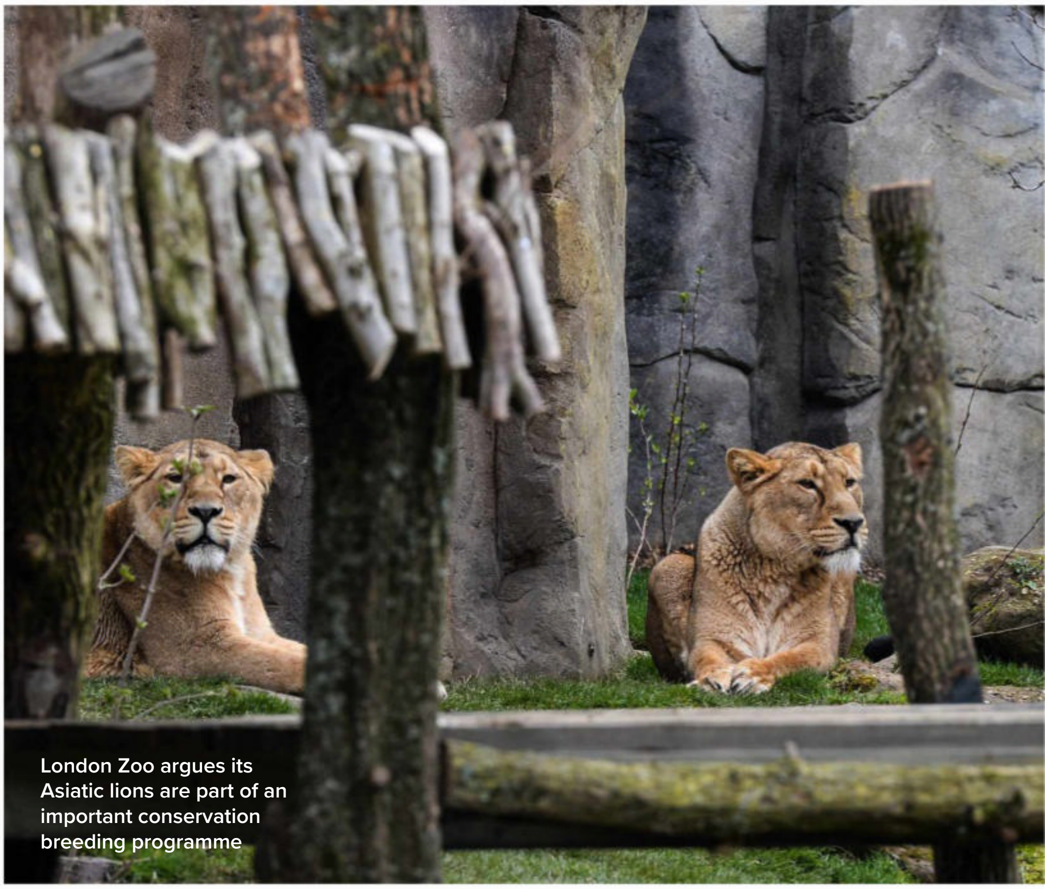
ZOO QUEST

Many people believe zoos have an important role to play in conserving species. We investigate if this really justifies keeping animals in captivity

By **JAMES FAIR**

SHAKA THE AFRICAN SAVANNAH ELEPHANT is standing in the middle of an expansive field, staring intently at us. His ears are forward, his face is alert and he doesn't appear stressed or, can we say, unhappy. He's a 33-year-old bull in the prime of his life at Noah's Ark Zoo Farm just outside Bristol, and he will be forever captive because of society's prevailing view that zoos are both good and necessary.

The transfer of Shaka to Noah's Ark Zoo Farm near Bristol was organised by the European Endangered Species Programme



London Zoo argues its Asiatic lions are part of an important conservation breeding programme

> "I justify zoos providing they are scientific, providing they are selective about what they keep and provided they keep them to the highest possible standards. That's okay by me."

DAVID ATTENBOROUGH, WILDLIFE TV PRESENTER

"Daddy's taking us to the zoo tomorrow, zoo tomorrow, zoo tomorrow," goes the song – a celebration of an exciting and wholesome day out. As Noah's Ark CEO Larry Bush says, visitors can encounter "the power of an African elephant" or watch an "Andean bear climbing a tree trunk", experiences that are arguably more intense and longer-lasting than watching the same species in a documentary.

"These animals are ambassadors for their wild cousins," says Bush. "It is educational and inspiring. Very few people can afford to go on safari in Africa, and it's not very good for the planet."

ABOUT THE AUTHOR

James Fair is a wildlife journalist with a specialism in conservation and controversial issues. Read more at jamesfairwildlife.co.uk.

SHAKA: NOAH'S ARK ZOO FARM; ASIATIC LIONS: CHRIS J RATCLIFFE/ GETTY; DAVID ATTENBOROUGH: JOHN PHILLIPS/GETTY

It is a fair point – why fly thousands of miles to see and smell exotic wildlife when you can pop down to your local zoo? Nevertheless, many people do question whether zoos have a role to play in 21st-century Britain. Why should animals – in particular, emotionally and socially complex ones such as Shaka – be sacrificed for their wild cousins in a way that we would never sanction for our own species?

There are three main arguments for the continued existence of zoos: they raise awareness about the threats facing wildlife; they use money raised to fund conservation initiatives in the wild; and their animals can be used for reintroduction programmes or act as ark populations in case of severe declines or, indeed, extinctions. Zoos also increasingly argue that they perform another vital function as community assets that are good for mental health.

Starting with the education angle, research by Eric Jensen from the University of Warwick has shown that about half of schoolchildren gained knowledge of and concern for endangered species after visiting a zoo, while families retained some of what they had learned even two years later. "Good zoos have the potential to deliver effective conservation-related outcomes," says Jensen.

A more recent meta-analysis of 56 studies published last year found a "small to medium positive effect" of engaging with zoo-led initiatives, with visitors more knowledgeable about conservation and more likely to act for the benefit of biodiversity.

But Will Travers, executive president of the animal welfare and conservation group Born Free, is not convinced. At London Zoo, which I visited with Travers and Born Free's captivity research and policy manager Chris

Bristol Zoo Gardens left its city-centre home in 2022 before reopening as Bristol Zoo Project

EXPLAINED

How are zoos regulated?

Local authorities have the responsibility for licensing, regulating and inspecting zoos. They can theoretically close zoos if they are not following the conditions of the licence.

There's no central register of all the zoos in the country, but Born Free says it has the most comprehensive database and that there are more than 300.

A document called the 'Secretary of State's standards of modern zoo practice' gives guidance on how zoo animals should be housed and other aspects of zoo husbandry. It is due to be updated. Part of the requirements on a zoo are to contribute to species conservation and public education.

Born Free argues that the current licensing system does not work. Local authorities have no real interest in properly regulating and inspecting zoos. Even where zoos with poor practices are identified, such as South Lakes Safari Zoo, councils rarely step in.

Born Free has long argued there should be a central inspectorate and regulator, similar to Ofsted for schools and Ofwat for the water industry.

Partula snails are cited as an example of a species saved by captive-breeding

Lewis, Travers points out how many of the visitors are parents with pre-school children.

"This is as much about entertainment as it is about anything more profound," he argues. "The idea that bringing children to see some animals in captivity is intrinsically valuable for its educational benefits is too simplistic in my view."

Outside the enclosure for Gir lions, where a lioness and her cubs doze in the weak November sunshine, Lewis questions just how much any of the people filtering through are learning about this extremely rare Asian subspecies. "They've gone, 'Ooh, a lion,' taken a picture and walked out," he says. "They haven't learned anything."

BUT THE TIMES THEY ARE a-changing. At Bristol Zoo Project, which is moving from its former city-centre site to a larger, out-of-town location, a whole section enveloped by broadleaved woodland is devoted to native, but extinct in the wild, British carnivores – bears, lynx, wolves and wolverines. Their enclosures are unusual in having plenty of places to skulk out of public view (though this is becoming more normal elsewhere), so you could visit without actually catching sight of any animals.

More importantly though, it's hard to come away from the exhibit without at least a smidgeon of understanding about how these predators once roamed our woodlands and why they disappeared.

Justin Morris, chief executive of Bristol Zoo, argues that zoos attract a broad cross-section of society and have a fundamentally different relationship with those people than other conservation organisations. "It can't be only the relatively well-educated middle classes that solve our environmental issues," he says. "Zoos have a role there."

When it comes to the so-called ark populations that zoos provide, let's make one thing clear – the vast majority of animals in zoos will never be reintroduced into the wild. For one thing, if their wild counterparts were ever to die out, the chances are it would almost certainly be too late for that species. You can't reintroduce a tiger if there's no forest for it to live in.

"A zoo will open its doors and say, 'Come and have a fun day at the zoo.' How can it be justified to call it fun when it basically means you're going to look at an animal in an enclosure?"

CHRIS PACKHAM, WILDLIFE TV PRESENTER AND CONSERVATION CAMPAIGNER

That's not to say that captive-bred animals haven't played a significant role in restoring populations and even saving species. Zoo-breeding techniques were used to save the Mauritius kestrel in the 1980s and more recently the Iberian lynx, when both were perilously close to extinction.

These weren't strictly zoo animals but zoos have been involved in other successful reintroductions – *Partula* land snails, for example, which have been bred in a number of UK zoos and used to repopulate their Tahiti island home. Plans were announced in 2024 to restore tigers to Kazakhstan, with two captive Amur tigers, previously held at a zoo in the Netherlands, used as breeding stock for offspring that will be released into a reserve in the south-east of the country.

But Lewis argues that examples of species that have been saved by captive-breeding are few and far between. "It's always the same species that are regurgitated," he says. "The California condor, the scimitar-horned oryx, the *Partula* snail. They are the exception, not the rule."

INDEED, IT'S NOT AS IF ZOOS MAINLY keep rare species. By 2035, Bristol Zoo is aiming to have 90 per cent of its collection classed as threatened with extinction and part of a conservation breeding programme, but the average for zoos in the UK is 25-30 per cent, according to Justin Morris.

Western lowland gorillas are classified as Critically Endangered by the IUCN because this subspecies has declined by 80 per cent over three generations. But in 2013 (the last year for which there is data) there were still an estimated 362,000 individuals spread over some 700,000km^2,

LOWLAND GORILLA: ADRIAN SHERRATT/ALAMY; *PARTULA* SNAIL: ROD WILLIAMS/NATUREPL.COM

> “In 2004, Detroit Zoo sent its elephants away to a sanctuary, on animal welfare grounds. People said visitor numbers would go down. They went up by half-a-million.”

LIZ BONNIN, WILDLIFE TV PRESENTER

though that population could be declining at a rate of 2.7 per cent a year.

“Would the IUCN identify captive breeding and reintroduction as a conservation strategy for western lowland gorillas?” asks Travers. “I think the answer is almost certainly not.”

And yet London and Bristol zoos both keep this species, so why would that be? “Studies going back years show that the most common animals in zoos are large, charismatic, cute, fluffy and have forward-facing eyes – they are the most attractive animals to visitors, regardless of their conservation status,” says Lewis.

FINALLY, LET US CONSIDER the role zoos play in field conservation – that by charging visitors, they can put money into in-situ work across the globe. The 2023-24 annual accounts for ZSL, which owns and runs London Zoo, show that its total income during the year was just over £83m, with expenditure of a little over £80m. Nearly £20m was spent on ‘science and research’ and ‘conservation and policy’, which sounds as if money raised from the zoo is indeed making a difference for wildlife.

But there’s devil in the detail. The accounts reveal that £14.5m of that £20m comes from ‘restricted’ sources, including ‘endowments’, so it isn’t raised by ticket sales. Arguably, the zoo could shut tomorrow, and ZSL would still be able to carry out the majority of its science and conservation work unimpeded.

London Zoo is part of a project to save Darwin’s frogs from the deadly chytrid fungus

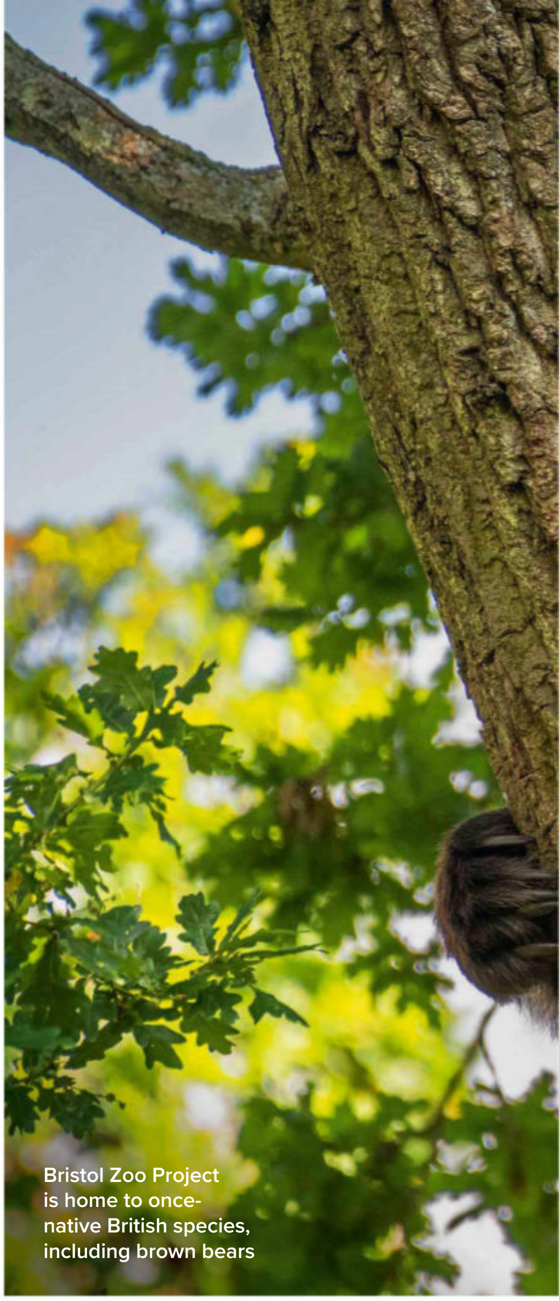
ZSL doesn’t see it that way. “ZSL is absolutely reliant on income from our two conservation zoos at London and Whipsnade to fund our global field science and conservation work, and their role in conservation far exceeds the provision of funds,” says chief operating officer Kathryn England.

As an example, she cites the rescue of 53 highly endangered Darwin’s frogs from a remote part of Chile because they were threatened by chytrid fungus, which had been detected near their Parque Tantauco forest home. They are now being cared for at London Zoo until they can be put back into the wild.

The 120 zoos that are members of the British and Irish Association of Zoos and Aquariums (BIAZA) contributed £33.5m to conservation in 2023 and worked in more than 100 countries, according to its chief executive Jo Judge. “Zoos are more important and relevant than they have ever been,” she says. “A good zoo – and there is no argument that there is any place for a bad one – has conservation at its heart.”

But does all this justify keeping wild animals behind bars? There are certainly species we previously maintained in captivity in this country and no longer do, notably dolphins – but that’s not because it’s illegal. Instead, a government-commissioned review argued that any facility that wanted to keep them would have to invest in bigger, deeper tanks, making it economically unviable.

The same could happen for elephants, say Travers and Lewis. Recommendations that are currently with the government would require all enclosures to be at least 20,000m^2. They say there are currently only 10 zoos that have elephants in the UK and only three of them – including Noah’s Ark – have enclosures that conform to these new regulations. But a report published by the Conservative Animal Welfare Foundation in 2022 suggested that even 20,000m^2 (2ha) is nowhere near sufficient – 100ha would be more appropriate, it said.



Bristol Zoo Project is home to once-native British species, including brown bears

NEVERTHELESS, ELEPHANTS have been the subject of a unique exercise in attempting to improve their lives in captivity. Lisa Yon, a professor in zoo and wildlife medicine at the University of Nottingham, has developed an app-based tool that allows elephant keepers to monitor and evaluate how their charges are faring over time. Behaviours that are assessed include relationships with other elephants, feeding and sleeping, and the presence of so-called stereotypic actions – repeated and well-defined movements or other acts – which indicate stress.

Yon’s research has led to the growing acceptance that elephants should be kept in related, multi-generational family groups because that’s how they live in the wild. “We found there were lots of social interactions in zoos where the elephants were related and very few where they

DARWIN’S FROGS: LONDON ZOO; BROWN BEAR: BRISTOL ZOO PROJECT; CHILDREN WATCHING SHARKS: DAN BURTON PHOTO/ALAMY; JANE GOODALL: JOEL SAGET/GETTY

Aquariums also come under scrutiny for the species of marine wildlife they keep

> “At the zoo of the future, you’ll need a lot of binoculars around the place, because your elephants will be far away and your chimpanzees will be five storeys up.”

JANE GOODALL, CONSERVATIONIST AND ENVIRONMENTALIST

weren’t,” says Yon. “Conversely, about 6 per cent of the behaviour was aggressive in the former, and one third in the latter. It was a huge difference.”

Noah’s Ark keeps a bachelor herd, a small group of four male elephants, as that’s how males live after they leave their maternal groups and before they become breeding animals. As well as creating the largest elephant enclosure in northern Europe, covering 80,000m², it has planted a willow copse in which the herd can browse as if they were wild.

The zoo also completely rebuilt its internal space, and the elephants can now come and go as they like. There’s a bank of sand indoors against which they like to sleep but, when it’s warm in the summer, they frequently opt for a night al fresco.

But can we even say whether Shaka, any elephant or indeed any animal in a zoo is happy? Lisa Yon is reluctant to do that but says we know when they are not mentally well – lots of ‘stereotippies’, aggression and not sleeping properly are all red flags. Travers has a different take. “You know when your dog is happy or fearful,” he points out. “We are not so divorced from other species that we can’t reasonably interpret how they are feeling.”

Back at London Zoo, Travers and Lewis say they’ve just seen a giraffe in an enclosure that is just “two tennis court-sized bits of flat land with some dead trees and branches strung up for browse”.

“Try to put yourself into the life of that animal,” says Travers. “It can’t choose where it lives, what it eats, who it mates with or what happens to its young.” We live in a society where choice is regarded as almost sacrosanct. But when it comes to all other animals, it seems that right is off the table.

Q&A

With Stuart Blackman
Email your questions to wildlifemagazine@ourmedia.co.uk

Does anything live at the top of Mount Everest?

TERRESTRIAL HABITATS DON'T GET ANY higher than the summits of Himalayan peaks. And Himalayan peaks don't get any taller than Everest. At 8,849m above sea level, the summit is exposed to extremes of wind, cold and oxygen-deprivation. Life is sparse at such heights.

Humans are almost certainly the only mammals to have set foot up there and, even then, only with technological assistance, and we don't tend to hang around for long. The only other mammal that gets close is the large-eared pika, a relative of rabbits, which reaches 6,400m in the Himalayas (though yellow-rumped leaf-eared mice have been recorded on the 6,739m-high summit of Llullaillaco in the South American Andes).

It might be that no life-forms bigger than a single cell can eke out a living on the roof of the world. Mosses aren't found higher than about 6,500m, for example. Among invertebrates, a single species of jumping spider ventures up to 6,000m, where it probably feeds on hapless insects blown in from elsewhere. Birds are mobile enough to drop by occasionally, though. Yellow-billed choughs have been spotted at 7,900m, and mountaineers have reported bar-headed geese flying over the summits of Everest and nearby Makalu.

Large-eared pikas can reach 6,400m in the Himalayas

Sealions are among the few mammals native to the islands

Everest's summit is so high that the amount of breathable oxygen is one-third of that at sea level

Why does New Zealand have so few mammals?

EVOLUTION HAS GREAT FUN ON ISLANDS. Their isolation means it has the luxury of working its magic for long periods away from mainland gene pools. The Galápagos, Hawaii, Madagascar, Mauritius all teem with species that are found nowhere else. And sitting all on its own in the south-west Pacific, 2,000km from the nearest landmass, New Zealand is no exception. More than half of its native species are endemic, including ancient and unique lineages of reptiles and plants and a spectacular variety of strange flightless birds. And yet something is missing.

> "It's not that there are no mammals, just very few of them"

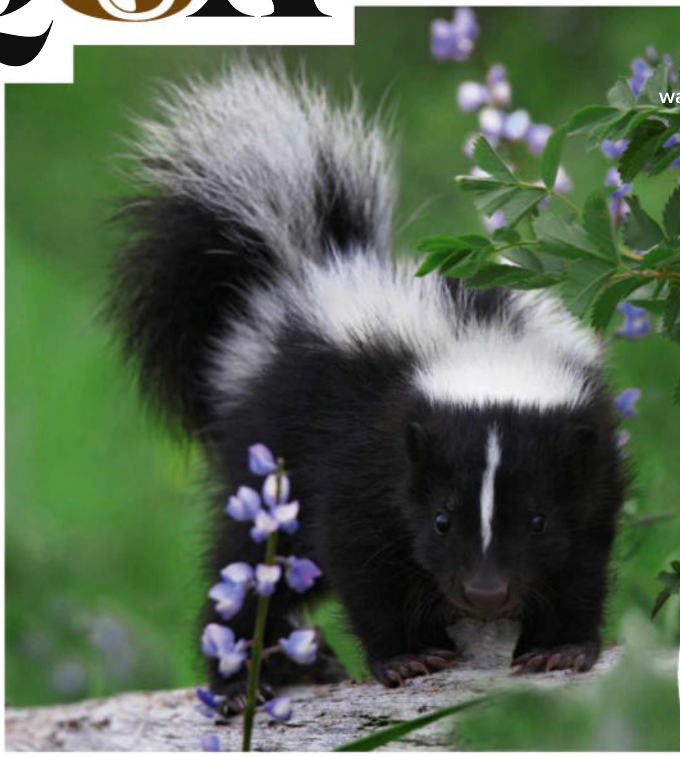
It's not that New Zealand has no mammals at all, or that it hasn't had them in the past. It's just that there have always been very few of them. The only native mammals on the islands now are three species of bat and various seals, sealions and cetaceans. The paucity of terrestrial mammals is explained by New Zealand's quirky geological history. Until about 80m years ago, it was part of the supercontinent of Gondwanaland. This was still the age of the dinosaurs but fossil evidence shows that at least one species, known as the Saint Bathans mammal, was present when New Zealand split from the mainland.

As New Zealand drifted eastwards, it started sinking under its own weight, to the point that only a few small islands remained above water. That New Zealand exists at all today is due to its position on the boundary between two of the great tectonic plates – the Pacific and the Australian. Volcanic activity around this weakness in the Earth's crust caused new land to rise from the water.

Over millennia, birds, bats and insects were able to colonise the islands. However, no terrestrial mammals were able to make the sea crossing. Ecological niches conventionally occupied elsewhere in the world by mammals were filled by moas, kiwis, kākāpō, weka, takahē and other birds that ditched their aerial capabilities in favour of a life on terra firma.

This unusual community endured in splendid isolation until around 1280 when New Zealand was colonised by Polynesian islanders, the Maori, who brought with them rats. And after their arrival in 1769, Europeans introduced three more species of rodent, as well as weasels, stoats, ferrets, hedgehogs, rabbits, cats and brushtail possums. New Zealand now has more mammals than at any point during its history. But introduced mammalian predators have contributed to the extinction of such endemic birds as the bushwren, huia and North Island snipe.

MOUNT EVEREST: FENG WEI PHOTOGRAPHY/GETTY; LARGE-EARED PIKA: HEMIS/ALAMY; SEALION: RUSSELL LAMAN/NATUREPL.COM



The skunk's stripes are thought to act as a warning to other animals

The magpie's distinctive uniform

Why are some animals black and white?

BLACK AND WHITE IS A BOLD SARTORIAL combination that is always likely to turn heads – which is often the whole point of it. Take skunks, which are as well known for their black-and-white stripes as for the noxious concoction they squirt from their anal glands. These two defining features are not unconnected. It is thought that the stripes serve as an aposematic signal – that is, one that warns would-be assailants that the signaller is armed and dangerous.

There have long been suspicions that the plumage of magpies also serves an aposematic function, advertising the birds' unpalatability to hawks and other raptors. But experiments have found that their eye-catching appearance attracts avian predators rather than deters them.

Another theory is that it facilitates species recognition in these gregarious birds. Or it might be used to signal an individual's quality to potential mates. A problem with that idea, though, is that non-breeding juveniles have the same colour scheme as the adults, so they would be carrying the costs of their conspicuousness while reaping none of the benefits.

A role for sexual signalling is perhaps more convincing in the case of the pied flycatcher, a species in which males compete among themselves for the attention of multiple females. While females and juveniles are brown and inconspicuous, adult males are decked out in a striking monochrome pattern, and only during the breeding season.

But sometimes it has more to do with blending in. Many seabirds, from gulls to guillemots and puffins to penguins, are black and white. The darker shades often occur on their upper surfaces and the lighter ones on their undersides, an arrangement known as countershading. This provides camouflage both from above, against a dark sea, and from below, against a bright sky.

Similarly – and perhaps counterintuitively – the big blotches of black and white decorating giant pandas and Malayan tapirs can make them harder to spot in their forest habitats. From a distance, the patterns break up the animal's outline, while at closer range they provide camouflage against a backdrop of patchy forest light.

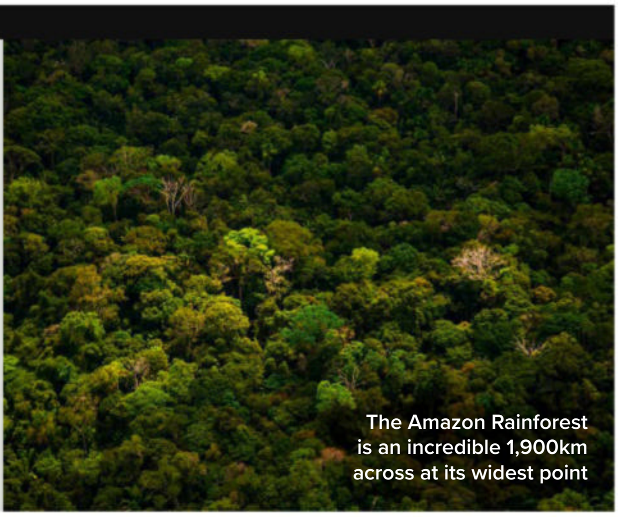
> "Turning heads is often the whole point of it"

Which leaves perhaps the most iconic of all black-and-white animals. It's still far from clear why the zebra has its stripes. There is no shortage of theories, including camouflage among tall grasses, temperature regulation in strong sunlight, and optical illusions that dazzle predators, causing them to mistime their attacks. There is also good evidence for the idea that the stripes are a defence against biting flies, possibly because the patterns prevent the insects locating the underlying blood vessels.

RECORD BREAKER!

What's the largest forest?

This is a tricky one because there is no universally recognised definition of a forest – how high or dense the trees must be, or how wide a treeless zone can stretch before one forest counts as two. It's probably safe to say that the Amazon Rainforest is the largest forest in the tropics (about 8 million km², according to the IUCN). But globally, there's competition from the coniferous Taiga forest that shrouds much of northern Eurasia, Canada and Alaska – though to count that as a single forest, you'd have to ignore an ocean or two.



The Amazon Rainforest is an incredible 1,900km across at its widest point

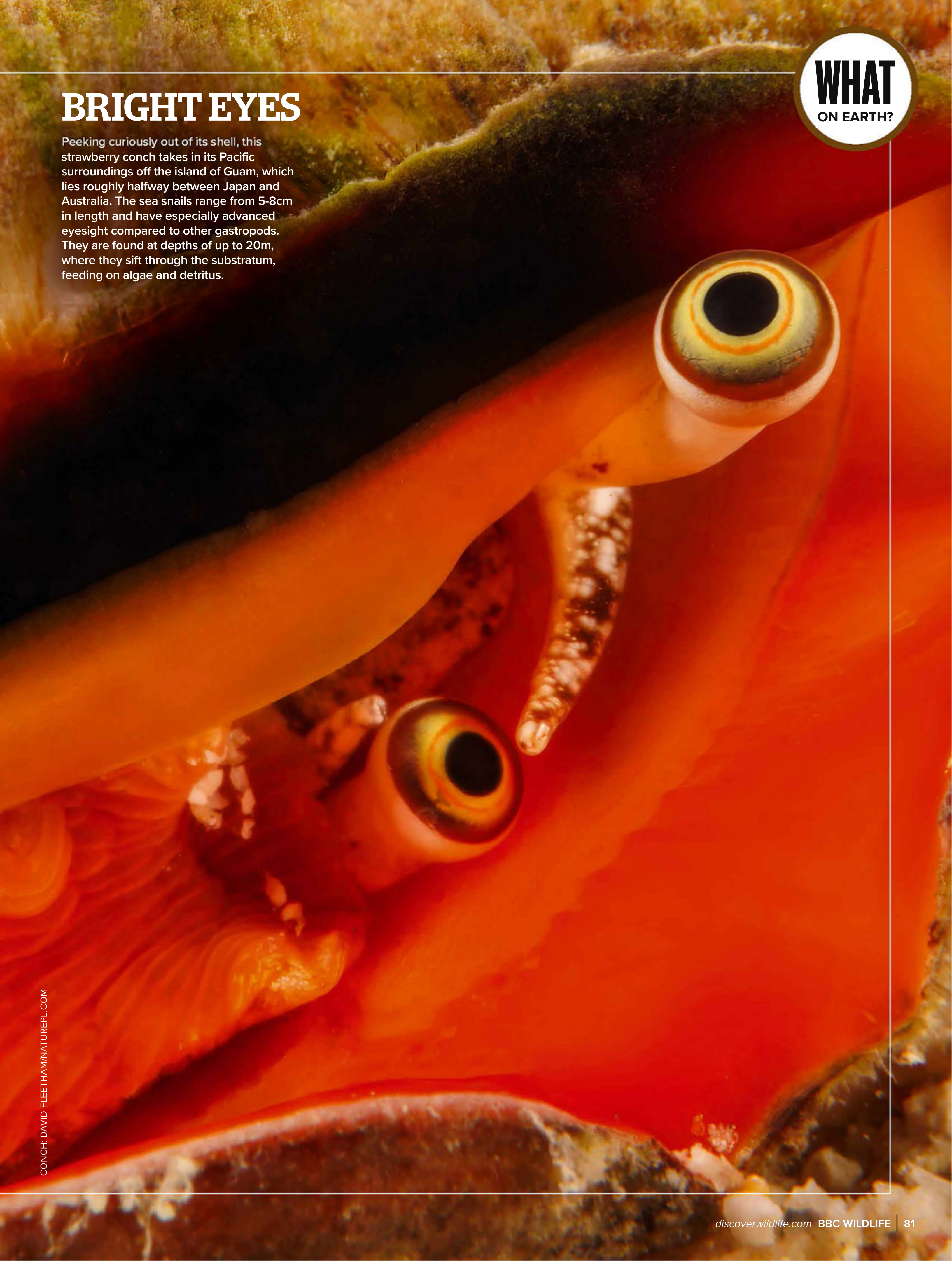
FACT.

Eating poo, known as coprophagy, is common in many animals, such as the salamanders that consume bat droppings. Such 'waste' material can often contain valuable nutrients.

SKUNK: TIM FITZHARRIS/NATUREPL.COM; MAGPIE: MIKE LANE/ALAMY; RAINFOREST: AMAZON IMAGES/ALAMY

BRIGHT EYES

Peeking curiously out of its shell, this strawberry conch takes in its Pacific surroundings off the island of Guam, which lies roughly halfway between Japan and Australia. The sea snails range from 5-8cm in length and have especially advanced eyesight compared to other gastropods. They are found at depths of up to 20m, where they sift through the substratum, feeding on algae and detritus.



CONCH: DAVID FLEETHAM/NATUREPL.COM

The outstretched talons of an osprey, pictured in Cairngorms National Park

What's the difference between claws and talons?

CLAWS AND TALONS ARE THE CURVED, pointy structures that grow from the tips of an animal's digits, and there's not much difference. Both are made of a tough protein called keratin (as are hooves and toenails) and are used variously for catching prey, climbing trees and fighting off predators and rivals.

Whether we call a talon a claw, or a claw a talon, has more to do with convention than biology. While 'claws' is a catch-all term for curved, pointy bits on the ends of the limbs of any animal (including invertebrates such as crabs and scorpions), we tend to reserve 'talons' for the ones wielded by the predatory birds known collectively as raptors – eagles, hawks, falcons and owls.

The only other claws that are routinely called talons are those belonging to predatory dinosaurs. As it happens, the members of one family, the Dromaeosauridae, are also commonly known as 'raptors', after the most well-known member, the *Velociraptor*. Which is appropriate, given that Dromaeosaurids are closely related to the earliest birds.

FAST ANSWERS

A giant land snail coasting along

Why are snails so slow?

Snails are built for all-terrain locomotion rather than speed. By gliding around on a trail of sticky mucous, they can negotiate pretty much any surface. But stickiness is not conducive to speed. In order to move at all, a snail generates waves of contractions in its muscular foot that pass from the back to the front. These compress the mucous, changing its physical properties from sticky to slippery, allowing sections of the foot to glide forward while others remain stuck to the surface. Most snails are scavengers and herbivores, so they don't need to move faster.

Can alligators and crocs interbreed?

Crocodiles and alligators occupy different families within the order of reptiles called Crocodilians, and those two families split off from each other about 90m years ago. Having been evolving independently for such a long time, the two families will have accumulated changes at the level of genetics, biochemistry, physiology and behaviour that make them incompatible reproductively. Successful hybridisation is only possible between species that diverged much more recently, such as polar bears and brown bears, which diverged about 100,000 years ago.

What is a mustelid?

Mustelid describes any mammal belonging to the family of carnivores called the Mustelidae: weasels, stoats, martens, polecats, otters, badgers, wolverines and others. These agile, pugnacious predators have a reputation for punching above their weight. The smallest (and the smallest of all carnivores), the least weasel, a familiar UK species, can take down a rabbit five times its size.

A stoat in Norfolk. Don't mess

OSPREY: THE BIG PICTURE/NATUREPL.COM; GIANT LAND SNAIL: KONRAD WOTHE/NATUREPL.COM; STOAT: GARY K SMITH/NATUREPL.COM

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INSTANT EXPERT

Electroreception: a shocking sense

WITH EVOLUTIONARY BIOLOGIST JV CHAMARY

ELECTRICITY IS THE RESULT OF interactions between objects with electric charge – and batteries aren't the only things that can be charged. Like the top and bottom of a battery, the inside of a living thing can have a negative charge while the outside is positive, or vice-versa, making it electric.

What is electroreception?

It's the ability to sense an electric field, the physical forces produced by attraction and repulsion (electromagnetism) between charged objects, which spreads through a surrounding medium like ripples in a pond. In water, the charge across an animal's surface interacts with dissolved molecules in the medium: opposite charges attract, like-charges repel.

Electroreception can be passive or active. For the passive sense, an animal detects electric fields created by other individuals (such as nearby predators, prey or mates) due to the charged surface of their bodies or muscle movements, which are controlled by electrical impulses and so affect the surrounding field.

How are electric fields detected?

An electric field is sensed via microscopic voltmeters called electroreceptors – pits in the skin connected to nerve endings – and perceived as patterns of voltage across the skin. In amphibians and fish, thousands of receptors (known as 'ampullae of Lorenzini' in cartilaginous fish such as sharks and rays) occur along the lateral line. Each pit leads to a canal filled with a conductive gel.

Which fish are electric?

Some fish are capable of active electroreception or 'electrogenesis'. An animal uses a dedicated electric organ (modified muscle tissue, typically in the tail) to generate its own electric field by discharging the organ. Electric fish can detect distortions in their field due to the presence of other objects, via distinct receptors. This allows them to communicate, navigate and find food by electrolocation – useful if a species is nocturnal or lives in murky water. Fish with weak discharges (often less than 1 volt) rely on electrolocation, an ability that evolved independently in two families of bony fish: freshwater elephantfish and knifefishes.

Of more than 30,000 total species of fish, only the 350 or so that can generate fields are classified as 'electric fish'. Passive electroreception, which occurs in 16 per cent of species, doesn't count.

How do they generate shocks?

Fish that deliver strong discharges can stun potential meals and enemies. Layers of fat and connective tissue help insulate their own bodies from the electric currents. The electric eel *Electrophorus electricus* (a knifefish, not a true eel like a moray) times shocks to trigger involuntary muscle contractions that reveal a prey's location. This causes fatigue when an eel is wrapped around a large target. A sister species, *E. voltai*, holds the record for strongest generator of bioelectricity: it can deliver shocks of 860v, half the voltage of a taser.

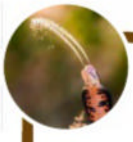
Do other vertebrates sense fields?

Yes, a few mammals can use passive electroreception. In monotremes, receptors in the bill let a platypus detect prey in water (despite keeping its eyes, ears and nostrils closed), while echidnas may be able to locate insects by sticking their snout/beak into moist soil. In true mammals, at least one marine species – the Guiana dolphin – uses 'vibrissal crypts' (pits where they once had whiskers) as receptors for detecting electric fields, in addition to using echolocation.

And what about invertebrates?

Scientists traditionally studied aquatic creatures such as fish because water is a good conductor of electricity, thanks to all the charged molecules it contains (water is rarely pure H_2O). By contrast, as a medium for electric fields, air is a poor conductor as its molecules are relatively few and travel fast. This is why the ability to detect fields isn't common among land animals.

But recent studies have found that bees and other terrestrial arthropods have hairs or antennae that can detect electric fields in air: aerial electroreception. This is, if you'll pardon the pun, an emerging field of research.



NEXT MONTH

BALLISTICS

How animals and plants shoot things

ELECTRIC EEL: MARK BOWLER/NPL.COM; SPITTING COBRA: MEDIA DRUM WORLD/ALAMY

A guineafowl pufferfish, puffed up as a defence mechanism

ALL YOU EVER NEEDED TO KNOW ABOUT

Pufferfish

BY JO PRICE

Pufferfish are toxic water 'balloons' that know how to defend themselves against predators. But their impressive arsenal isn't the only thing that's fascinating about them. They have evolved a beak-like mouth and some of the most unusual teeth you'll see underwater. Some are even sand artists – their beautiful seabed creations puzzled scientists until 2011, when the mystery was solved.

Where do pufferfish live?

Pufferfish are primarily found in warm tropical and subtropical waters but some live in brackish and even fresh waters.

How big are pufferfish?

The largest species of pufferfish is the giant freshwater pufferfish (*Tetraodon mbu*), which is found in Africa and can grow to more than 60cm long. The smallest species is the dwarf pufferfish (*Carinotetraodon travancoricus*), which lives in India and is approximately 2.5cm long.

Why are they so deadly?

Pufferfish are highly dangerous to eat as most species contain tetrodotoxin (TTX), a lethal poison acquired from certain bacteria in their diet. The toxin accumulates in their liver, gonads, skin and intestines. Pufferfish themselves are immune to TTX because of a genetic mutation that prevents the toxin from affecting their nerves. Some females even coat their eggs with TTX to deter predators.

What does pufferfish poison do?

TTX binds to nerve cells, blocking signals and causing paralysis, often leading to death by suffocation. There is enough poison in one pufferfish to kill 30 adult humans. In Japan, the preparation of fugu, a pufferfish delicacy, is strictly regulated. Only specially trained chefs can do it.

What predators do pufferfish have?

According to the Natural History Museum, "Only the toughest species, such as tiger sharks, common octopus and sea snakes, will take on a puffer thanks to some astounding adaptations."

What do pufferfish eat?

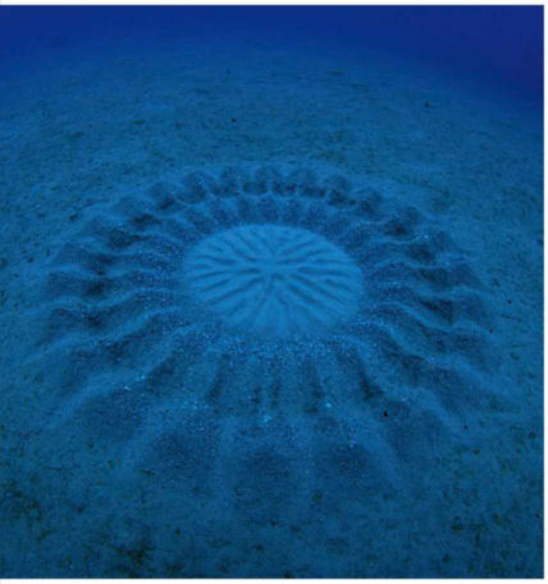
Pufferfish primarily feed on invertebrates and algae. Larger individuals use their strong beaks to break open and consume shellfish such as clams and mussels.

What is unusual about their teeth?

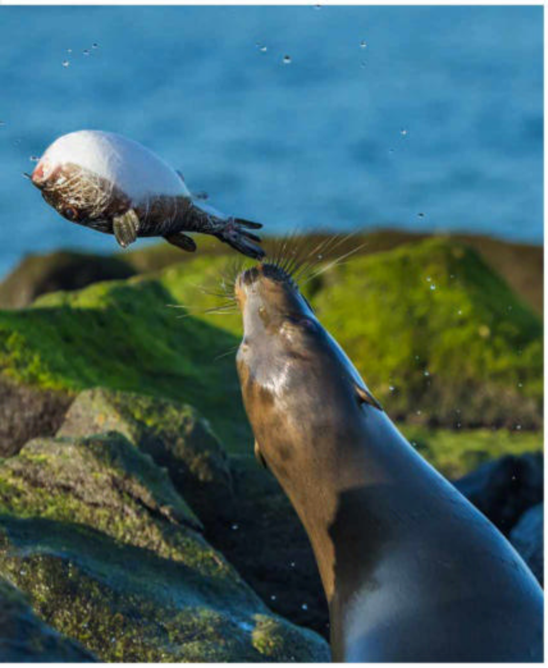
The pufferfish's beak is formed by multiple replacement generations of only four teeth, which elongate along the jaw and are fused together.

How do pufferfish inflate?

Pufferfish are slow swimmers with small fins so can't escape predators quickly. They rely on puffing up to make themselves too big to eat. They undergo this incredible



The gaudy black-spotted pufferfish among coral in the Philippines



Top: The ornate sand patterns of the white-spotted pufferfish. Above: A Galápagos sealion plays with a pufferfish

transformation by sucking water (or air if they're out of the water) into their elastic stomachs. Their modified gill muscles and lack of ribs enable them to swell like a balloon. The process, known as buccal pumping, allows pufferfish to grow up to four times their usual size.

Do they hold their breath when inflated?

No. When they inflate, pufferfish continue to breathe with their gills. A *Biology Letters* study in 2014 reported that the oxygen uptake of the black-saddled pufferfish (*Canthigaster valentini*) while inflated increased to five times that of resting levels.

Why do pufferfish make circles?

The white-spotted pufferfish (*Torquigener albomaculosus*) is responsible for ornate, geometric formations, which are made by males to attract mates. The fish flap their fins as they swim along the seafloor, disrupting the sediment and making circular patterns, which are adorned with pieces of dead coral and seashells. According to *Scientific Reports*, "Males dug valleys at various angles in a radial direction, constructing nests surrounded by radially aligned peaks and valleys."

How does the white-spotted pufferfish breed?

Once the week-long building process is complete, the nest is inspected by females. If they're impressed, mating follows. Eggs are laid by the female in the centre of the circle and the male fertilises them externally. The female disappears after laying and the male guards his brood until they hatch.

Are pufferfish of conservation concern?

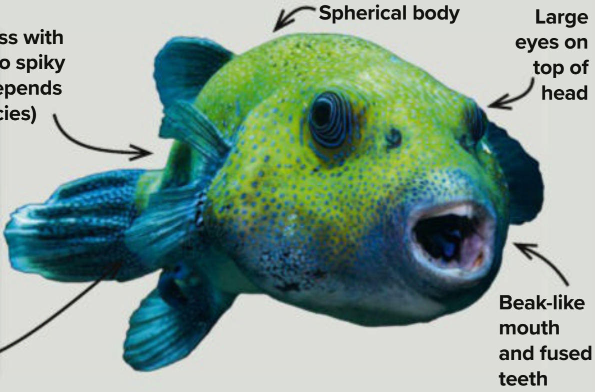
This varies depending on the species. Most populations are considered stable, but some species are vulnerable due to pollution, habitat loss and overfishing. The Chinese puffer (*Takifugu chinensis*) is classed as Critically Endangered by the IUCN. Its global population is estimated to have declined by 99.99 per cent over the past 40 years because it is among the top four fugu species in Japan.

What's the difference between pufferfish and porcupinefish?

Pufferfish belong to the family Tetraodontidae; porcupinefish to the family Diodontidae. Sometimes collectively known as 'puffers', they are easily confused as both belong to the order Tetraodontiformes. Porcupinefish can inflate, but are also armed with well-developed spines.

A PUFFERFISH'S SPECIAL FEATURES

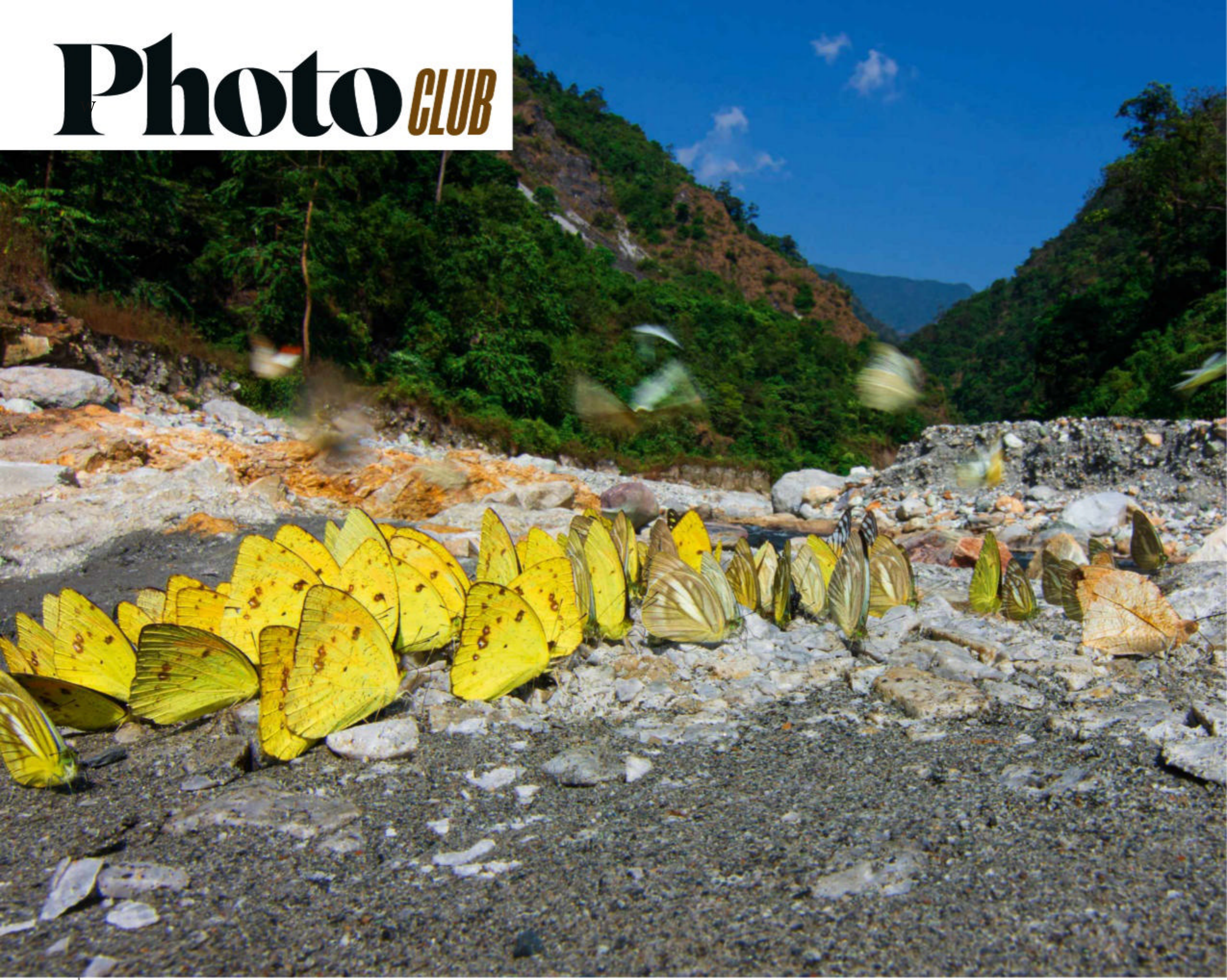
AT A GLANCE
Scientific family name: Tetraodontidae
Max length: Approx 60cm (*Tetraodon mbu*)
Lifespan: Average of 10 years


Scaleless with rough to spiky skin (depends on species)
Spherical body
Large eyes on top of head
Beak-like mouth and fused teeth
Two pectoral fins, anal fin, caudal fin, dorsal fin

NEXT MONTH

LEAFY SEADRAGON
Camouflaged marine creature

GUINEAFOWL PUFFERFISH: DAVID FLEETHAM/NATUREPL.COM; SAND PATTERNS: NATURE PRODUCTION/NATUREPL.COM; SEALION: TUI DE ROY/NATUREPL.COM; BLACK-SPOTTED PUFFERFISH: DAVID FLEETHAM/NATUREPL.COM; CUTOUT: GEORGETTE DOUWMA/NATUREPL.COM; LEAFY SEADRAGON: JAMES PEAKE/ALAMY

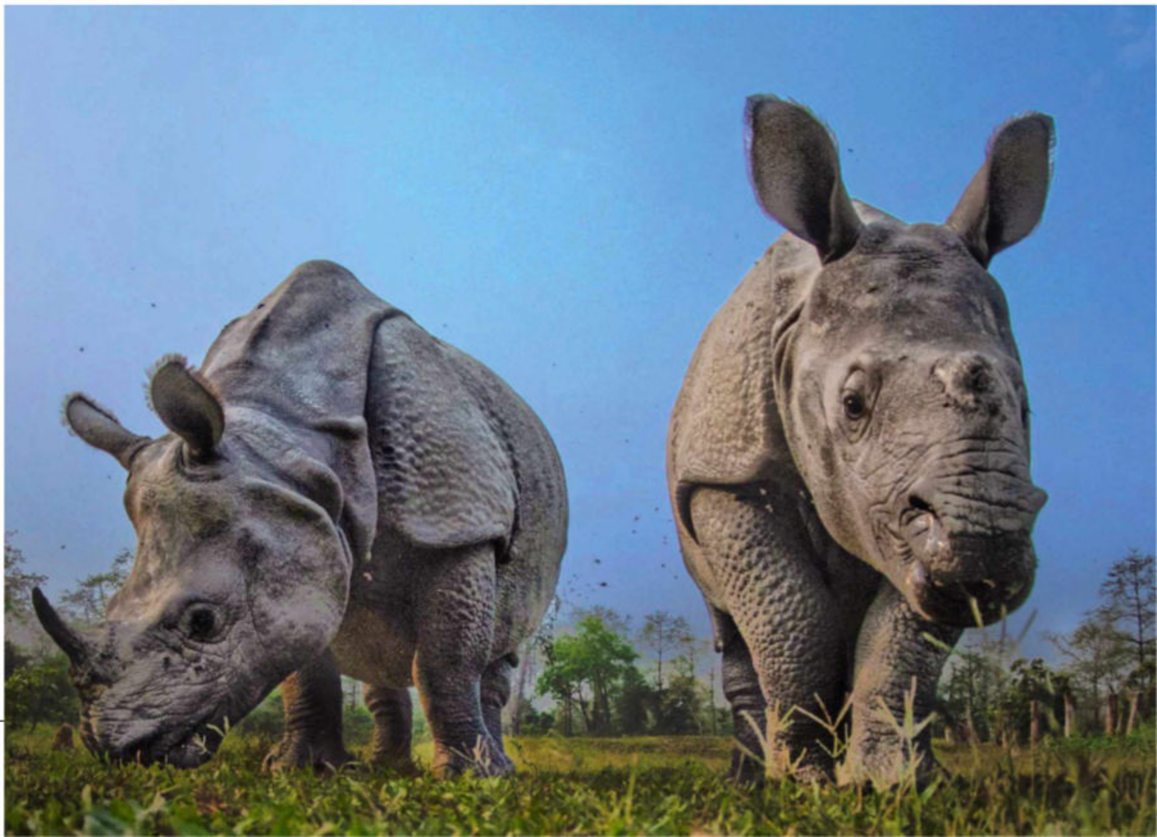


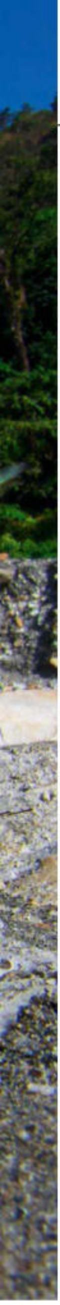
Wing walkers

Butterflies add a streak of sunshine at the India-Bhutan border – a foul experience for me as they touch down to sip moisture from mud puddles created by urinating travellers.
Saurabh Chakraborty, Kolkata, India

Hide and seek

I spotted this greater one-horned, or Indian, rhino mother and calf in Assam's Manas National Park. The species has a characteristic armour-plated appearance.
Hema Palan, India





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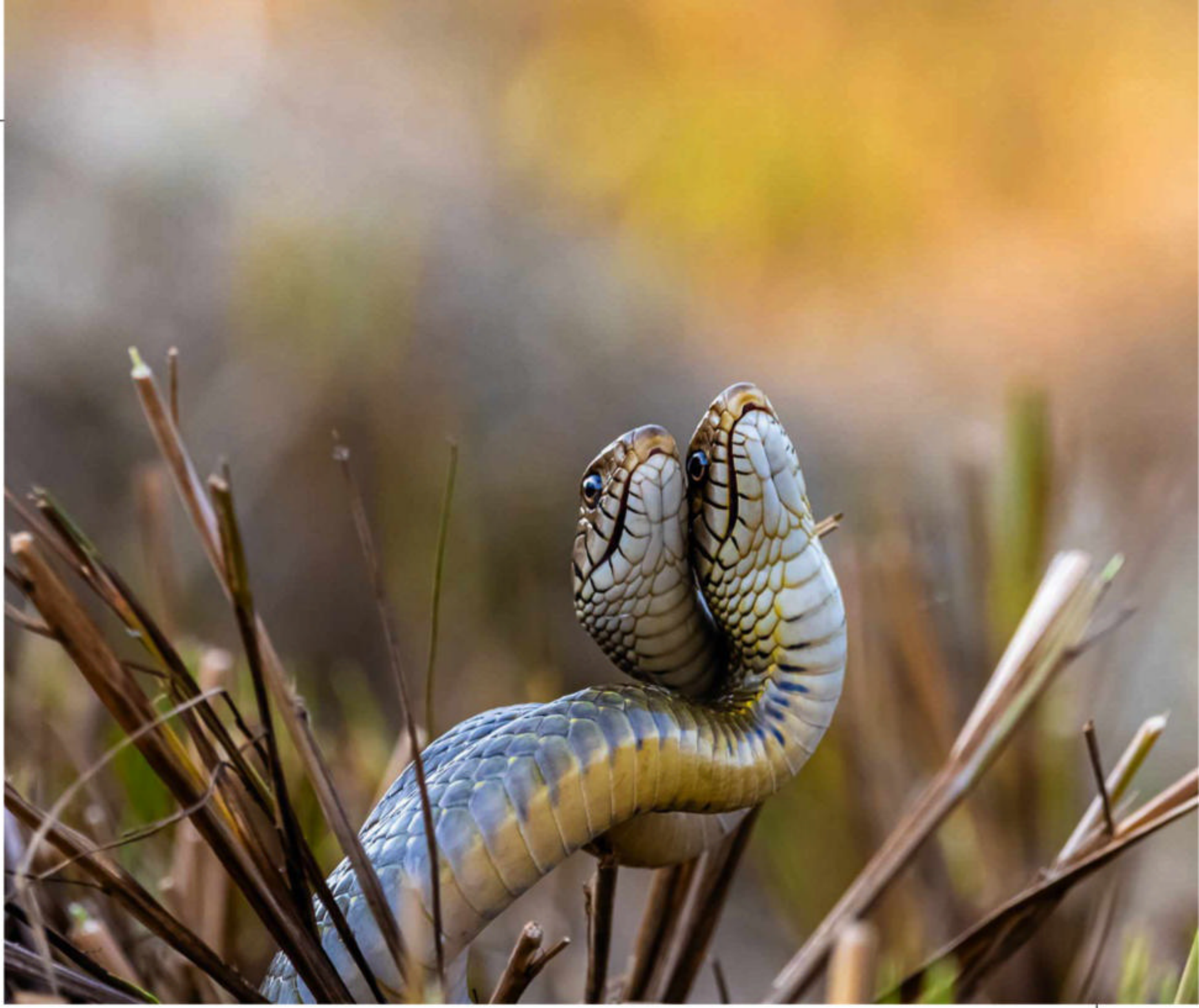
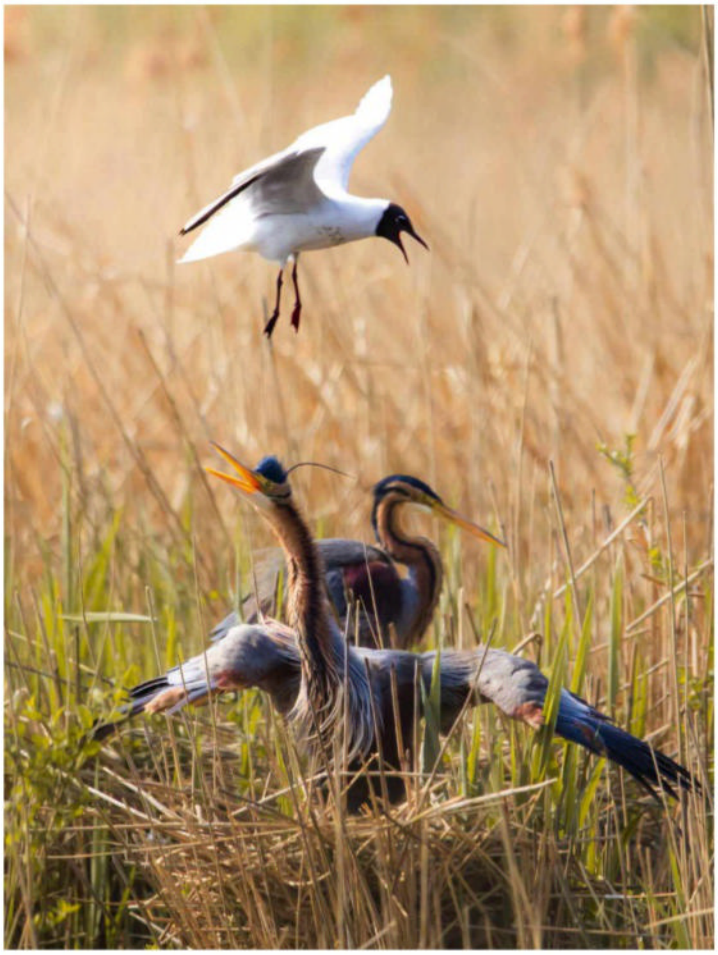


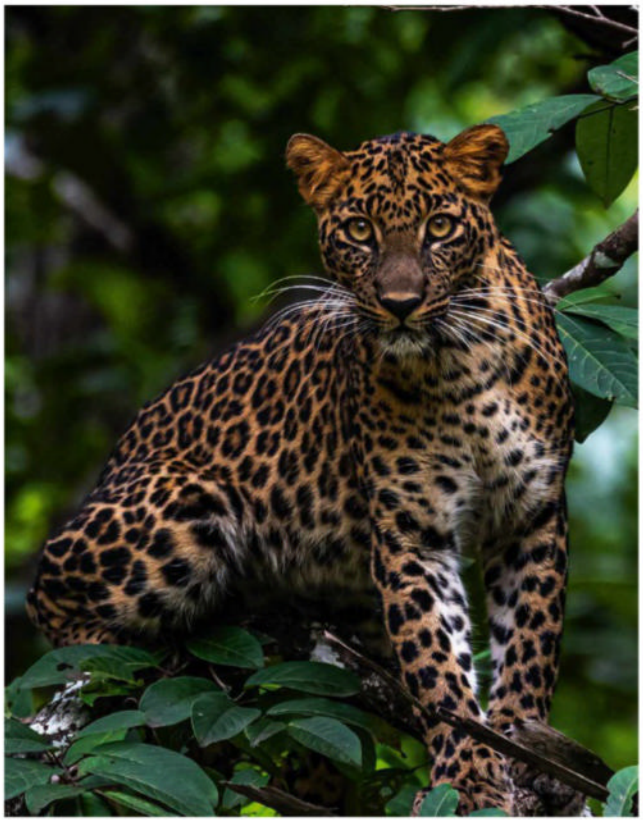
Fight club

These rat snakes were in combat, so getting the shot was tough as they moved so fast. After two-and-a-half hours I nailed it.
Ahamed Jazif, Sainthamaruthu, Sri Lanka

Protection racket

I watched a nesting colony of purple herons under noisy attack from gulls, a fascinating wildlife event.
Marie Rack, Cologne, Germany





Leopard encounter

The sleek form of this enigmatic female materialised from the shadows of the Bhadra Tiger Reserve. We watched, awestruck.
Deepak Ranjan Dash, Baleswar, India

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Derek scales the heights to capture wildlife

SNAP-CHAT

THE INSIDE WORLD OF WILDLIFE PHOTOGRAPHY

Derek Nielsen on charming chimps, wise elephants and ants in his pants

How did your career start?

Out of curiosity. I've always been fascinated by the natural world and then I fell in love with photography, so I decided to use my new skills to raise awareness.

Which of your images is the most important to you, and why?

Two come to mind, showing undeniable love. The first is of a baby orangutan clinging to its mother, finding safety in her arms as we all do in our early years. The second is of an adult elephant with its trunk embracing a youngster's trunk, as if hugging. So relatable.

Is there a shoot you'll never forget?

Camping on the shores of the Antarctic Peninsula with my wife, I saw a full moon rising, so I took out my telephoto lens to capture it. Later, when reviewing the images, I found I'd caught a humpback whale breaching and my heart just about exploded.

What has been your most memorable wildlife encounter?

I was photographing chimpanzees in the jungle canopy when one sneaked up and sat beside me. After several moments of non-verbal communication, I switched lenses and captured her. Her eyes pierced my soul in a way I'll never be able to explain.

Can you remember any close calls?

Once, in Cambodia, our guide was telling us about some men harvesting honey in the forest when, without warning, the entire colony of hundreds of thousands of bees came down on us like rain. It was deafening. We dived under a mesh net for protection.

Derek on location

DEREK NIELSEN

Do you have any epic fails to share?

My first trip to shoot mountain gorillas in Rwanda was a total fail. I was so excited about the experience that my photography knowledge went out of the window and almost all of my shots were blurry. I was so caught up in the moment that I forgot to check my settings – a humbling experience.

What has been your favourite species to turn your focus on?

Elephants. Their complex minds and compassion for one another make me feel deeply for them. I am fascinated by the way the elders take care of their young or share their wisdom about the environment. Every time I am around elephants, I learn something new. They are so powerful yet sensitive and delicate.

Which species is top of your bucket list?

I'd love to photograph polar bears before it's too late. Animals like these need us to continue to raise awareness of the impacts of habitat loss and climate change.

Have you had any challenging shoots?

Killer whales, particularly the southern resident killer whales of the Pacific Northwest, are a challenge. I'm currently filming a documentary about their fight for survival, and it has been a test. They're protected, so getting close to them is almost impossible, and they spend so little time above the surface that it's hard to know when they'll pop up. Photographing them can be a nightmare – but it's so worth it.

What is the worst discomfort you've endured in the name of photography?

In Rwanda, photographing primates, I went ahead of our group one day to capture birds in the canopy. I stopped to zoom in on one, unaware that driver ants were climbing up my legs, all the way to my trunk. When they started biting it was incredibly painful. In a panic, I ripped off my trousers and was standing in my underwear, screaming – just as the rest of the group caught up.

Which piece of photographic kit would you never be without?

A lens cloth. Dust, moisture, a whale's ocean spray or a primate's fingerprints all impact image quality. A polished lens is a must.

Any tips for budding photographers?

Don't compare your work to that of others. Study and support them, but remember they are on a different path. I have been rejected or passed over so many times. If you love what you are doing, stay the course.

Derek Nielsen is a wildlife photographer from the USA. See his work at dereknielsen.com.

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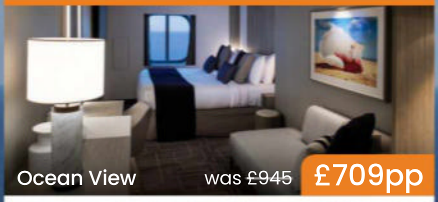

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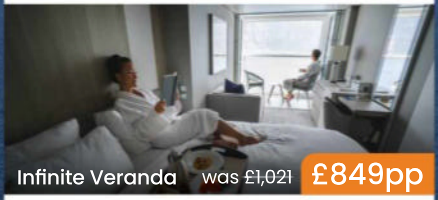

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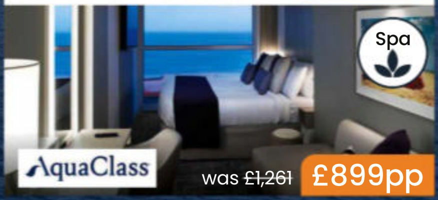

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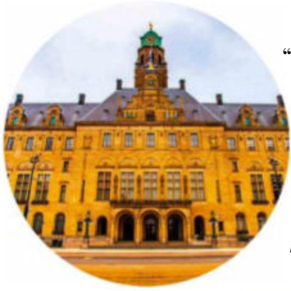

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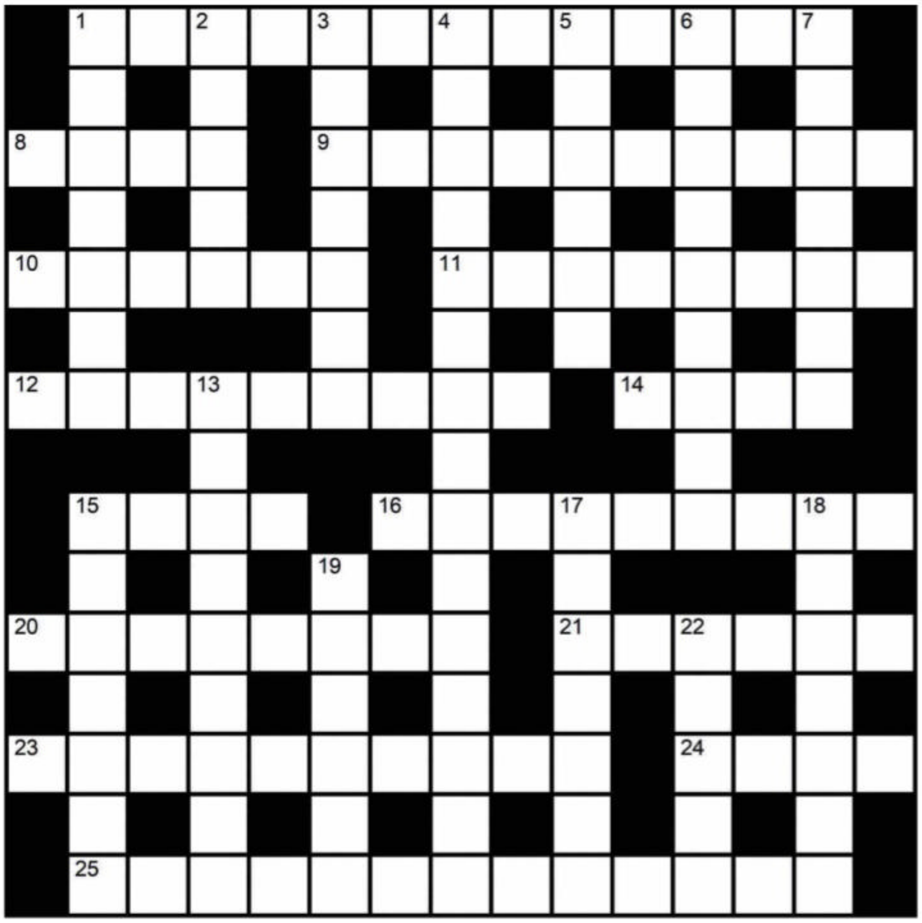
wild PUZZLES

The crossword

ACROSS
1 Bunny colonies (6,7)
8 Journal of the British Ornithologists' Union (4)
9 Heathery (10)
10 East ____, region of England, rich in fen and farmland (6)
11 Former term for a sloth or anteater (8)
12 ____ tailorbird, species discovered in Phnom Penh in 2009 (9)
14 Hawaiian goose (4)
15 Insects in the order Hemiptera (4)
16 Wildflower in the genus *Meconopsis* (4,5)
20 Red-____ merganser, saw-billed duck (8)
21 Shrub in the mint family, native to the Middle East (6)
23 Shark in the family Sphyrnidae (10)
24 Mountain goat (4)
25 Cranefly larva (13)

DOWN
1 Locust tree genus (7)
2 Aromatic herb (5)
3 ____ gull, seabird of the far north Atlantic (7)
4 Widespread American ungulate (5-6,4)
5 Vocalised like a lion or bear? (6)
6 Asian shrub also called Siberian ginseng (9)
7 Move rapidly, like a crab, perhaps (7)
13 Wetland heather of North America (3,6)
15 ____ flathead, fish with a black-striped caudal fin (7)
17 Spiny monotreme (7)
18 Eden ____, Cornwall botanical garden (7)
19 Carbohydrate found in plants such as rice and cassava (6)
22 ____ insect, highly camouflaged member of the order Phasmatodea (5)



March crossword

Across: 9 *The Living Planet*, 10 Grackle, 12 *The Swan*, 13 Goldeneye, 14 Thrip, 15 Strider, 18 Hawkbit, 21 Nymph, 23 Desert rat, 25 Echidna, 26 Walleye, 29 Marbled murrelet

Down: 1 Stag, 2 Weka, 3 Milkweed, 4 Bigeye, 5 Eggteeth, 6 Albert, 7 Snow crab, 8 Stinkpot, 11 Roost, 15 Sunbeams, 16 Ram's horn, 17 Red panda, 19 Warblers, 20 Italy, 22 Huddle, 24 Sow bug, 27 Eels, 28 Etta

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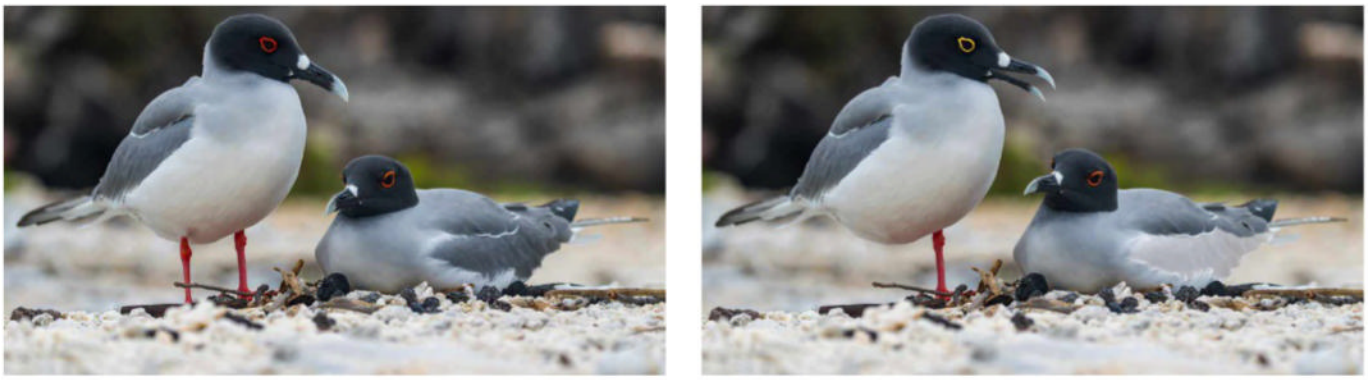
SPOT THE DIFFERENCE



These swallow-tailed gulls are incubating eggs on Genovesa Island, part of the Galápagos Islands. The species is the world's only nocturnal gull and forages at night for squid and small fish. Can you spot all five differences between the two images? Turn to page 94 to find the answers.

CROSSWORD COMPILED BY RICHARD SMYTH
GULLS: TUI DE ROY/NATUREPL.COM

Your LETTERS

Greenfinches have been badly hit by disease in the UK

Garden habitats for birds

I am belatedly making my way through the February issue and have just read James Fair's piece about feeding birds. What a brilliant article! Some years back, my family unwittingly contributed to the decline of greenfinches (and probably other species as well) because we never cleaned our birdfeeders. Since learning about trichomonosis, we regularly clean our birdfeeders now and encourage friends and family to do the same. I agree with James's sentiments that we should be incorporating at least some wildlife-friendly features into our gardens, whether that's planting native flowers, letting flowers go to seed, or providing logpiles and other dark and overgrown areas for slugs, beetles and other invertebrates. Not everyone is lucky enough to have a garden, and they are such important habitats for so much of our beleaguered wildlife. While supplementary feeding can be helpful during the winter and spring, it's somewhat perverse that we remove the natural feeding opportunities from our gardens, only to then provide the food back to the birds via feeders.
Laura Howles, via email

Oyster reefs

I am currently studying for an animal science degree and used the news article 'Oyster reefs in ruin' from the March issue for an assignment. It was about the conservation efforts for an endangered species. There is a group in the Netherlands called Oyster Heaven that has come up with a clever plan to restore reefs by placing large bricks in strategic locations that are seeded with 100 young oysters. The structures help to mimic a reef and support the young until adulthood. It's a cheap and effective solution and people can even adopt these 'mother bricks' to aid in oyster conservation.
Helen Waddison, via email

European predators

Never have I read such a profound first sentence as the one in Mark Carwardine's column in the March issue, on living alongside predators. It's so true – hunting and farming interests have far too much influence and sway in Britain and even more so in Europe. I'm born and bred in South Cumbria and am constantly frustrated by a lack of action regarding wildlife persecution and the constant undermining of reintroduction schemes. I think we need a robust re-education system for both the general public and the farming community.
Harold Taylor, South Cumbria

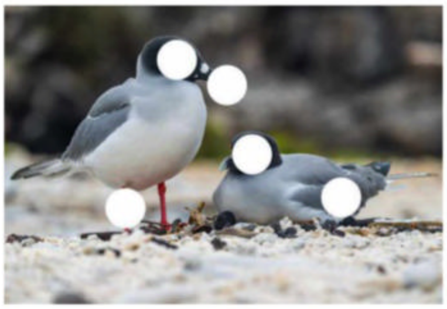
Mark Carwardine's article about Europe's lack of tolerance of predators got me thinking about why we need to hunt these poor beasts to prove our dominance of them. Yes, humans did originally wear animal skins and hunt for survival. But, just as we have decided that wearing fur is not necessary in our modern societies, can we not have the intelligence and foresight to live with acceptance alongside these beautiful carnivores, understanding that they are essential to a healthy planet?
Julie Lane, via email

Morning sickness

Regarding the question in Q&A in the Spring issue, 'Do any other animals get morning sickness?', I used to breed Burmese cats and, after taking them to stud, I always knew if they were pregnant because they were always sick first thing in the morning. I asked the stud owner about it and she said that it was normal morning sickness and would pass within a few days. So, I would say yes, perhaps some animals do get morning sickness.
David Richardson, via email

Return of the crane

I've just read Mike Dilger's column on the common crane in the March issue. It's a good summary of the crane's new lease of life in the UK but I'm puzzled as to why WWT Slimbridge was not mentioned as a great place to see these birds. Up to five pairs bred there last year and four chicks successfully fledged. Some of the best places to see them at the reserve are from the Estuary Tower, the Zeiss Hide and the Hogarth Hide on the South Lake. The pair at the latter raised two chicks and I saw all four together there recently.
Mike Davis, via email


Answers to Spot the Difference on page 93

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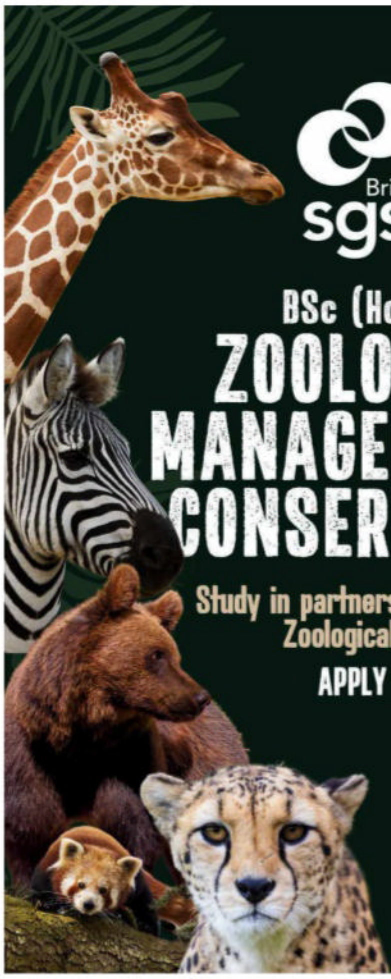

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Today, Elkhorn Slough boasts the highest concentration of sea otters in California – here a mother and pup

NEXT MONTH

Estuary engineers

Two decades ago, California's Elkhorn Slough was polluted to the verge of ecological collapse, its rich seagrass meadows smothered by mats of algae. Then, something remarkable happened: sea otters arrived, and the estuary made a dramatic recovery. This is the story of a habitat brought back to life by one of nature's most charismatic ecosystem engineers.

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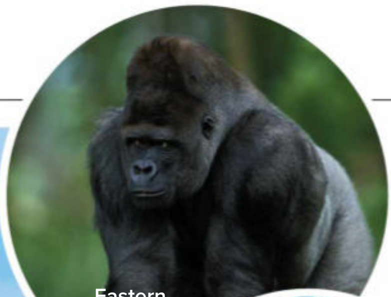
Top TEN

The African bush elephant – one of nature's heavyweights



Eastern gorilla

Saltwater crocodile

Coconut crab

Super-strong animals

Some of the world's mightiest creatures, from crabs to crocs

1. African bush elephant

Not only the largest living land animal, the African elephant is also thought to be the strongest animal on Earth in terms of the sheer amount it can lift. It is capable of lifting the equivalent of its own body weight – all seven tonnes of it. Much of the species' strength is found in its complex trunk, which contains up to 40,000 muscles.

2. Dung beetle

Elephants may lead the pack by sheer lifting power but, when it comes to strength relative to body size, dung beetles – which get their name from their diet of animal poo – are even more impressive. One species, the horned dung beetle, which is just 10mm long, can pull more than 1,000 times its own body weight.

3. Eastern gorilla

Adult male gorillas, which can reach a height of about 1.7m and weigh as much as 220kg, are the strongest primates in the world and capable of lifting up to 10 times their own body weight. One of the first written accounts of the gorilla, by the English traveller Andrew Battel, was published 400 years ago in 1625 – and he was clearly taken aback by the animal's raw strength: "Those pongos [gorillas] are never taken alive, because they are so strong that 10 men cannot hold one of them."

4. Harpy eagle

The world's strongest bird is thought to be the harpy eagle, native to Central and South America. It has been recorded carrying prey weighing as much as half its own body weight, and snatches tree-dwellers such as monkeys and sloths straight from the branches using its enormous talons.

5. Saltwater crocodile

The animal with the strongest bite-force – and the animal considered to be the most likely to eat a human – is the saltwater crocodile, the world's largest living reptile. With a range from eastern India to northern Australia, it can be found living in mangrove swamps, deltas and freshwater rivers. A 2012 study found it to have the highest bite-force quotient ever recorded for an animal in a laboratory setting.

6. King snake

The limbless reptile able to exert the strongest constriction pressure relative to body size is thought to be the king snake, found in North America. It is able to apply about twice as much force relative to its size, making it a formidable predator.

7. Coconut crab

This absolute giant of a crustacean, found on tropical islands in the Indian and Pacific Oceans, can reach a colossal 3.7m from claw to claw and feeds on other crabs, rats and even large seabirds. The strength of the species' appendages is perhaps best demonstrated by its ability to crack open coconuts – hence its name.

8. Blue whale

By virtue of its massive size and powerful swimming and diving abilities, the blue whale is thought to be the owner of the animal kingdom's most powerful muscle, the peduncle, which runs from the dorsal fin to the fluke. When these cetaceans dive, the peduncle helps to propel them as much as 300m below the surface.

9. Polar bear

Reaching up to 2.5m in length and more than half a tonne in weight, the polar bear has a bite-force strong enough to crush bones, powerful swimming muscles and formidable lifting power, making it the strongest land carnivore. This is evidenced by the dramatic sight of bears dragging huge seals out of the water and across the ice.

10. Giant palm salamander

Found on the forest floors of Central America, the giant palm salamander is able to flick out its tongue with 18,000 watts of power per kilogram of muscle – more instantaneous power than any other known muscle in the animal kingdom. It takes the amphibian 7 milliseconds to extend its tongue fully. That's 50 times faster the blink of an eye. **Leoma Williams**

NEXT MONTH

LIVING FOSSILS

A glimpse of the distant past

ELEPHANT: STEVE HOLROYD/ALAMY; GORILLA: MAURITIUS IMAGES GMBH/ALAMY; CROCODILE: SEATOPS/ALAMY; COCONUT CRAB: GARY ROBERTS/ALAMY; HORSESHOE CRAB: WATERFRAME/ALAMY

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